POWER

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The Universality of Power

MUCH has been said about the extent to which power produced by fuel or falling water has reduced the arduousness of the day's work.

The nearer one gets to the ground and to the primitive methods of the back roads, the more this is borne in upon one.

The hewing of wood and the drawing of water, the tilling of the soil and the culture and gathering of its products, the dairy and household processes, spinning, weaving, cobbling, cooking have passed into power-driven processes and industries with the details of which the consumer is little more concerned.

The tasks which were beyond man's muscular capacity and for which he domesticated and maintained horses and cattle, transportation particularly, are fast coming to be taken over by power-operated machinery, relieving man of the work required to raise and maintain and produce the food supply of these animal helpers.

One is prone to think of power only as a factor in the operation of factories, railroads, etc., and its use in this way has mitigated, to an extent that is little recognized, the necessity of muscular manual exertion on the part of the individual. But there have been two comparatively recent developments that have made power in small amounts available for the ordinary processes of the household and the farm.

The first of these is the widespread and growing use of electricity as a means of power distribution. Networks of wire carry the current produced in great power stations so that over extended areas one may have, by the pulling of a switch or the pushing of a button, the energy for the rapid and tireless performance of the tasks that added so much to the fatigue and took so much of the time of the day.

The second is the internal-combustion engine, which, by making power available in small units, has made tractor and other operations possible, and, through the automobile, obliterated inaccessibility and isolation and increased the radius of the existence of the dweller in out-of-the-way places.

F. R. Low

Making Electrical Drives Safe in Pulverized-Coal Plants

Methods Used To Eliminate the Explosion Hazard in Pulverized-Coal Plants and How To Select Motors and Controllers for These Applications

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IT IS commonly known that powdered coal, when permitted to collect in clouds, is highly explosive if ignited. It is therefore necessary to prevent a detonating agent existing where a material amount of this dust accumulates. Such agents present in power plants include open flames such as occur when opening a controller contactor carrying current or from sparking between commutators or collectors and their brushes.

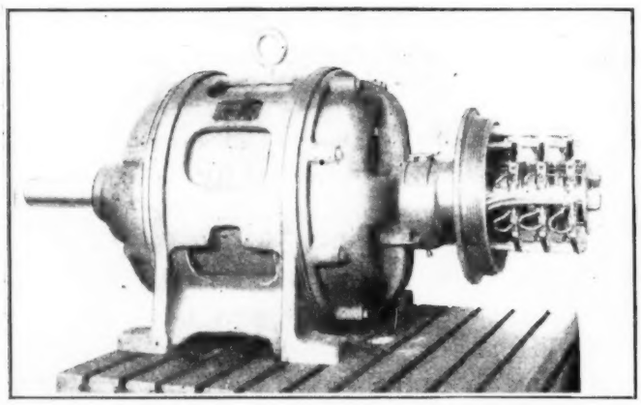
One method of preventing ignition from such sources is to inclose the motors and controls totally. In doing this, the ventilation of the motors presents difficulties, since the largest motor that it is considered economical to inclose totally, is 25 hp. Above this rating self- and forced-ventilated motors are required. Many of the motors used in power plants are of such low speed that self ventilation is not possible, hence special blowers with specially arranged ducts to circulate clean air are required.

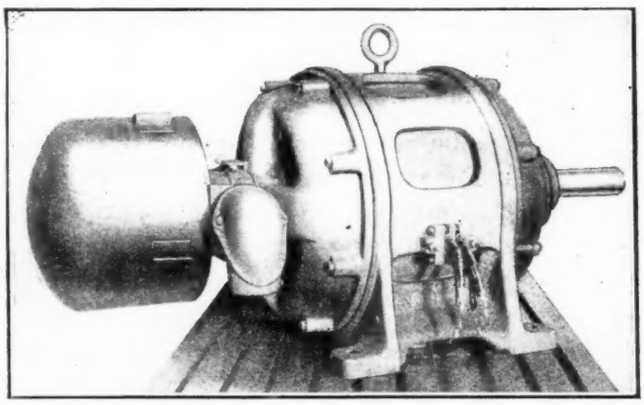
There were many objections to this plan, and other means of coping with the dust conditions were investigated. The present method was precipitated by the experience of totally inclosed motor failures amid such dust conditions as existed in the earlier installations of pulverized-fuel equipment. In some instances where a short-circuit developed within the motor, the motor frame opened up and the arc ignited the coal-dust clouds, causing extensive damage. It was thus found that a totally inclosed dust tight motor was not necessarily explosion proof. This led to the conclusion that it was highly undesirable to have coal dust existing about the station, and the possibilities of dust prevention were investigated.

Some power stations using screen-type pulverizing mills from which dust escapes, isolated the coal-preparing equipment in a separate building or dust-tight compartment. By stopping up leaks in the conveying system and piping used in conveying the powdered coal about the plant, coal dust was eliminated from the boiler room. The motors used in the preparation compartment were of the totally inclosed, forced-ventilated type, a supply of clean air being maintained by blowers.

In later installations, from economy of space considerations, it was found that isolating the preparing equipments was costly and the suction type of mill which had been developed was adopted. The powdered fuel was exhausted from the pulverizer mill by medium-pressure air and conveyed to the storage bunker in suspension. This system was necessarily dust-tight and prevented the dust from escaping to the boiler and pulverizing rooms. With such a system made tight, the hazard of explosions was reduced to a minimum and the idea of explosion-proof equipment was superseded by that of dust prevention.

With the explosion hazard reduced to a minimum, the trend was to simplify the ventilating schemes of the motors by the adoption of open construction types. It was found, however, that even if the coal dust did not escape in sufficient quantities to present an explosion hazard, some dust was always present in the boiler and fuel preparing rooms. It was further found that such dust presented a hazard to the motor windings in that the minute particles of coal dust were of a sharp and penetrating nature and so worked their way through the insulating material that the winding eventually became short-circuited.





Figs. 1 and 2—Wound-rotor induction motor with sealed sleeve bearings, showing method of inclosing the slip rings in a dust-tight box outside the bearing bracket

ust also caused undue wear of the motor bear-pecially where the pressure per unit surface was

Types of Motors and Control

To meet the conditions described herein and permit using motors of the open-construction type, motors have been developed with special features for these applica-

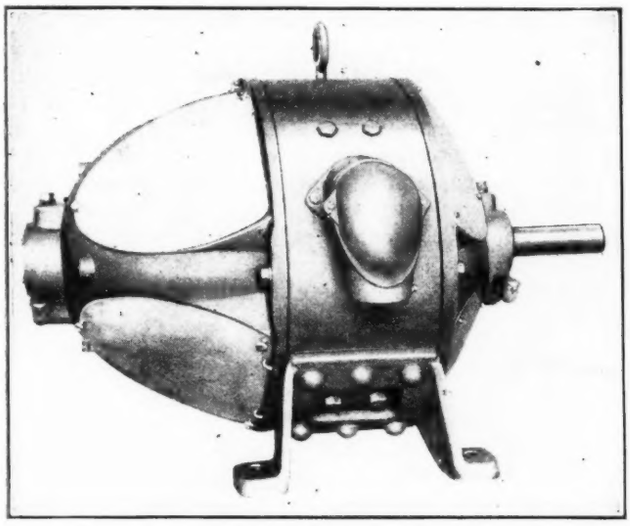


Fig. 3—Totally inclosed dust-tight direct-current motor

tions in the form of dust-resisting insulation and sealed sleeve bearing.

Dust-resisting insulation is obtained by putting it through a special impregnating process consisting of a number of varnish dips and bakes before and after the coils have been assembled in the motor. This treatment gives the coils a smooth non-porous finish which the dust cannot penetrate, and does not decrease the heat-dissipating ability of the coils.

With the seal-sleeve bearings, moisture, dirt or air cannot get into the bearing and the oil cannot get out. Incidentally, the maintenance of bearings is reduced to a minimum, since oiling is required but once a year with a good-grade lubricant.

Where open-construction type motors are applied, additional precaution is necessary to prevent possible injury to the motor. To conform to the electrical safety code it is required that all moving contacts be inclosed. In the case of alternating-current slip-ring motors this may be done external to the bearing bracket and the open-construction motor used. In cases where direct-current motors are applied, they should be totally inclosed. However, the use of direct-current motors in a pulverized-fuel plant is limited and, when used, they are usually small enough (less than 25 hp.) to be totally inclosed.

There are some applications in the pulverized-fuel plant, such as conveyors, elevators, etc., where the motors are subject to possible leaks and consequent dust conditions and it is considered good practice to make them of the totally inclosed type, since they are small enough to permit this being done economically. Such totally inclosed motors are always larger in size than motors of equivalent rating of the open-construction type, since all the losses must be radiated from the external surface.

The control recommended for pulverized-fuel equipment drives is dust-proof, but not dust-tight or explosion proof. These terms have been used interchangeably and incidentally misused, and so that it may be fully understood just what each implies, the Power Club definitions are given:

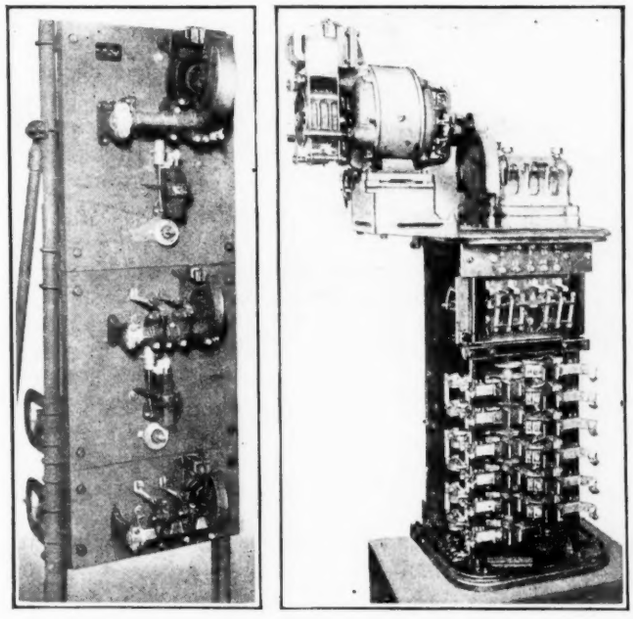
Dust-proof apparatus is apparatus so constructed or protected that the accumulation of dust will not interfere with its successful operation.

Dust-tight apparatus is apparatus so constructed that the dust will not enter the inclosing case.

Totally inclosed, without further qualification as to ventilation, means that no air is introduced into the motor and no provision for air outlet is made. Whatever ventilation there is consists of a churning action of air normally inside the motor, and dissipation of heat takes place by radiation from the external surface. This construction is not necessarily air-tight.

In contrast to this construction, totally inclosed self-ventilated, means that fans on the rotor are used to circulate air through the motor from the outside by specially arranged ducts or pipes. Also the totally inclosed forced-ventilated construction means that separate motor-driven blowers are used instead of fans on the rotor, as in the self-ventilated. Various other forms of inclosures are used, but they will not be discussed here.

The dust-tight construction is similar to that of the submersible type of apparatus used in marine applica-



Figs. 4 and 5—Controllers for wound-rotor motors

Fig. 4—Constant-speed magnetic-contactor type of controller; enclosing cabinet not shown. Fig. 5—Motor operated variable-speed drum-type controller, with cover over contact removed.

tions. Such control equipment has very limited application in the pulverized-fuel plant, being confined to some push-button stations where it may be desirable to have water, gas and dust-tight stations.

The motor control equipment in pulverized-fuel plants may be hand operated, located adjacent to the motors or it may consist of equipment operated by push buttons or master switches near the motor, the oil circuit breaker, contactor panel or motor-operated drum switches being located in any desired position.

Drives for pulverized-fuel equipment are not just a miscellaneous group of motor and control, but a carefully selected group compatible with the main units. Each pulverized-fuel installation is a complete engineering problem, and an analysis of the mechanical, physical

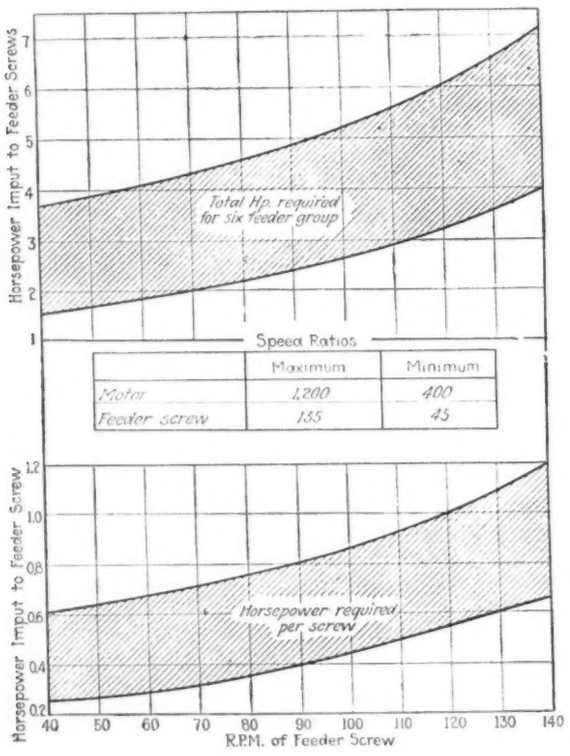


Fig. 6—Typical fuel-feeder power requirements for individual and group feeders

and economical features is essential before the final selection is made.

For the motor drives the simplest and most reliable type of motor consistent with economy of operation should be used. As to the relative advantages of alternating and direct current, the tendency in pulverized-fuel applications is to avoid direct-current motors, except where greater flexibility is obtained by their use.

Many of the pulverized-fuel applications operate at constant speed, and for such service the most dependable motor by virtue of its simple construction is the squirrel-cage induction type. The substantial construction of this type and the absence of any moving contacts provides a motor of high reliability.

Full-Voltage Starting Simplifies Control

Another feature that has added further to the simplicity of the squirrel-cage motor is the adoption of full-voltage starting. This method of starting simplifies the control to a minimum, requiring only a line breaker or contactor. The chief objection to full-voltage starting is that the motor produces an excessive starting torque, which in some applications such as chain- or belt-driven loads may cause trouble. In such cases it is considered good practice to apply low-voltage starting equipment.

An objection to full-voltage starting in industrial applications and one of less consequence in power houses, is that at starting a squirrel-cage motor draws four to ten times normal current from the line. This excessive current tends to cause a drop in voltage, and in smaller systems the voltage may be reduced to unsafe values, such as to cause stalling of the motors. In large systems the capacity of the power source is sufficient to reduce this effect. The power factor of squirrel-cage induction motors during starting is very low.

To limit the starting current, improve the power factor at starting and thereby permit the use of smaller sources of power, wound-rotor induction motors are sometimes used for constant-speed application. These motors run at constant speed, the secondary resistance being inserted only during the starting period. Slip-ring motors are usually started on full voltage on the stator winding, but the control must provide for the proper resistance in the rotor-winding circuit.

The slip rings of the wound-rotor motor are inclosed external to the bracket in a dust-tight box, Figs. 1 and 2. The connections from the rotor windings to the rings are brought out through the center of the shaft, which is hollow. The cover is built in one piece and screws to the stationary support on the end of the bearing housing. With this form of construction no screws or bolts are used which may be lost or left out.

Some Variable-Speed Drives Used

There are some variable-speed drives in the pulverized-fuel plant, such as forced- and induced-draft fans where the wound-rotor motor is applicable. The construction of these motors is the same as for the constant-speed type, Figs. 1 and 2, the difference being in the secondary resistor which is for continuous duty and laid out to give the required speeds. In the selection of such motor drives it is necessary to know accurately the fan characteristics, since a small change in speed will cause a large change in the power requirements.

Of the variable-speed motor drives the pulverized-fuel feeders require a wide range of speed adjustment

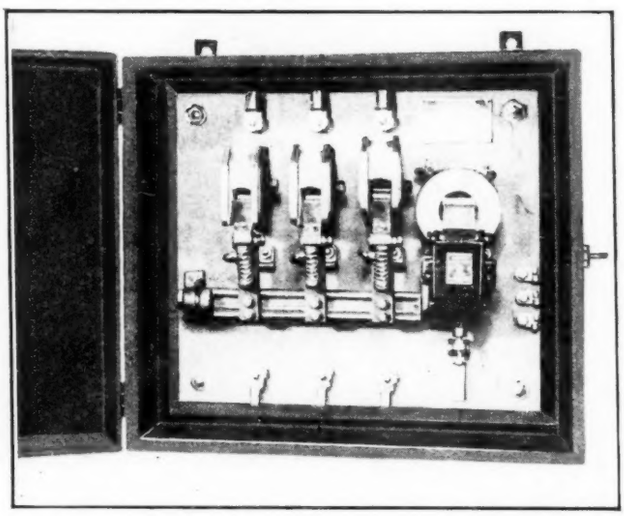


Fig. 7—Across-the-line magnetic starter for squirrel-cage induction motors with push-button control

in a comparatively large number of steps. It is important also that speed remain constant for any given adjustment since the pulverized fuel is burned as fast as it is fed into the combustion chamber. This requirement is the essential difference of a pulverized-fuel feeder drive from that of a stoker drive. With a

stoker-fired boiler momentary fluctuations in stoker speed do not affect the combustion efficiency so long as the correct average speed is maintained. With the pulverized-fuel drive, however, any small momentary fluctuation in the speed of the fuel feeder immediately affects the combustion, as there is no storage of burning fuel in the furnace.

The horsepower input of a typical fuel feeder is shown in Fig. 6. The width of the cross-sectional areas shows the variation in horsepower and consequently the torque changes in operation. These changes in power requirements are caused by changes in the friction of the fuel due to varying moisture content, head of powdered coal in the bin above the feeder screws, and the condition of the feeder. Since the horsepower requirements vary, wound-rotor induction motors with secondary-resistance speed control do not meet the conditions satisfactorily for fuel-feeder drives. At speeds below normal, small variations in torque produce corresponding fluctuations in motor speed.

Direct-current shunt motors with speed control by field adjustment, furnish one of the most satisfactory forms of drive for fuel feeders. The usual speed range is four to one in a large number of steps. For any given setting of the field rheostat the speed is constant and does not change with slight changes in torque. Where used, direct-current motors are totally inclosed, as in Fig. 3.

Armature control of direct-current motors introduces the same difficulties as encountered with the wound-rotor induction motor; namely, small variations in torque result in corresponding fluctuations in feeder speed, and is not recommended although it is used in some installations.

Incidentally, it might be pointed out that with armature control at one-third normal speed, two-thirds of the power input is consumed in the resistor. For instance, to obtain minimum speed of the fuel feeders in Fig. 6, 5 to 12 hp. is required with armature control, compared with 1.6 to 3.75 hp. by field control.

Full-Voltage and Low-Voltage Starting

In the selection of control for pulverized-fuel equipment drives, diversity of practice and opinion exists in the methods of starting.

Full-voltage starting has been briefly referred to and is the outcome of operating experience of some of the newer installations in power plants, which have pioneered in the simplification of auxiliary equipment. The advantages of full-voltage starting in pulverized-fuel plants are: Simplified control, automatic restarting, installation cost lower and elimination of explosion hazard. Some of the disadvantages are: Higher current taken from line and the high torque may cause trouble in some cases.

It is the practice of some operating companies to make all motors full-voltage starting. Other companies make the so-called essential auxiliaries (usually 2,300 volts) full-voltage starting and the non-essential 440-volt motors low-voltage starting. The use of the terms essential and non-essential are misleading, since no motor drive is of such little use as to be considered non-essential. Perhaps the terms continuous duty and intermittent duty are more applicable.

Motors for full-voltage starting need special bracing of the coils and if correctly designed for a particular application the starting torque will not produce any undue shock. In some special applications low-voltage starting is recommended. With full-voltage starting, across-the-line type of starters are used consisting of magnetic contactors or oil switches. Where used, the contactors are inclosed in a dust-proof case, as in Fig. 7.

With low-voltage starting the industrial auto-starter is not satisfactory for application in power houses, owing to its limited ability to resist both mechanically and thermally, the short-circuit currents encountered. Hence auto-transformer type of starters consisting of a panel with running and starting oil breakers of high rupturing capacity, should be used. Where the auto-starters are in use in power stations, they should be mounted behind steel panels.

For wound-rotor induction motors the control usually consists of a primary oil circuit breaker or magnetic contactor and a hand- or motor-operated drum controller or contactor for the secondary.

Where magnetic contactors are used, it is desirable to furnish them with direct-current holding coils, since with alternating-current coils energized from the line a dip in voltage will cause them to drop out and destroy themselves in case of short-circuit low-voltage conditions.

For the control of shunt-wound motors by shunt field, drum controllers are used which have several accelerating contacts which progressively short-circuit the armature resistor. When the last accelerating point is reached, the motor runs at its lowest operating speed. Moving the controller farther cuts in the field resistance step by step and increases the motor speed to a maximum.

Where drum controllers are used, they are inclosed with an asbestos-lined sheet-steel cover. Inclosed automatic starters with motor-operated faceplates inclosed in a separate cabinet may also be used for the control of shunt motors.

Draft Tube Caused Surging Turbine Speed

By M. B. Thurston

A hydraulic-turbine plant that gave a great deal of trouble in speed regulation, consisted of vertical spiral-case turbines built into the dam with a short penstock. The draft tube and connections were long, and the arrangement was such that the discharge from the turbines was carried away in a tunnel under a road and several other near structures. The draft tube itself had a length of 35 ft., being of the elbow type. This was connected to a tunnel 125 ft. long, the combination making up a water column 160 ft. in length. To make matters worse, the tunnel flowed nearly full at full load. Thus it will be seen that it required considerable time to accelerate this water column in case of increased load, and there was considerable suction effect tending to pull through the water on gate closure.

Several attempts were made to adjust the governors so as to minimize the effect of the surging, but to no noticeable result. The plant superintendent proposed an atmospheric vent of an area twice the canal cross-section. He contended that this would break up the continuity of the long column and dampen the surges. As other corrective measures did not help, it was decided to do this and maintain regular operation during the work. Not only was the surging stopped, which used to continue for five or six minutes at a time, but the extent of the surges was greatly reduced as well.

What Is Good Firebrick?

By HUGH E. WEIGHTMAN
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SPECIFICATIONS should balance many points. Rigid limits on one point may entail impossible conditions in some other detail. This is the first of two articles discussing the selection and testing of refractories.

IN SELECTING refractories by specification, the first item considered usually is the fusion point. The terms fusion point, softening point and melting point are used generally to mean the same thing; that is the determination of the approximate temperature at which the tip of a cone made of the ground clay or brick will soften sufficiently to bend over and touch the base or plaque on which the cone is mounted. In strict technical language these terms are not equivalent, but their continued use by salesmen and consumers has resulted in this loose terminology.

For all boiler refractories it is sufficient to specify that the materials have a softening point of 3,000 deg. F., if the softening point is considered at all. In comparing different refractories by softening point determinations, all the determinations should be made in the same manner and preferably in a furnace of similar atmosphere to that of the furnace for which the refractories are to be selected. This is difficult if not impossible, so most determinations are made with gas or oil as fuel and in furnaces of small volume in order to get clean conditions and high temperatures.

If the tests are made with cones of the same dimensions, with the same rate of heat increase, same fineness of texture of samples and the same fuel and furnace atmosphere, then results are comparable. But such tests will only serve to show up extremely bad refractories. Nothing is gained by selecting refractories by differences in melting point other than to select only those having a melting point above a certain minimum. As to service, a melting point of 100 deg. or so above the minimum does not insure a better refractory than one just at the minimum.

Chemical Analysis

Chemical analysis is of assistance only in the most general way. One serious difficulty is that a chemical analysis does not show the mineral composition of the refractory—that is, it reports the percentages of various compounds, but does not indicate how these are combined into various mineral groups. The analysis by chemical means plus a petrographic examination is of assistance to the manufacturer in determining the proper method of manufacture of refractories from the raw materials, but then only in the hands of an expert. The combination of these examinations is of assistance to the expert in the selection of refractories where the conditions of service are examined with equal care.

For boiler furnace refractories only a few general facts can be gleaned from a chemical analysis. Many of the published analyses of fireclay brick show a large quantity of moisture in the analysis. This is due to the analysis having been made of the clay from which the brick is to be manufactured. If this be not the case, then the work has been done by incompetent analysts. Usually, plant chemists devoting their time to products other than ceramic materials are not expert enough for analytical work of this kind.

Where the analysis has been made from the prepared clays, the resulting figures are difficult to handle because they do not show what the true analysis might be after burning. If only a short analysis of a few components has been made, it is likely that large errors have crept in. Assuming that an analysis of reasonable accuracy has been made, then a reasonable guess may be possible as to the refractoriness and mechanical strength of the product.

Excess Silica Detrimental

When silica predominates in a fireclay refractory, it combines with all accessory minerals to form silicates, and if an excess is present, free silica will result. This is detrimental to the life of the firebrick, since such silica is available to form additional accessory minerals with fly ash or other components of the fuel. The silica also has the unstable feature of excessive expansion and contraction, part of which is permanent and part reversible, so that there are changes in physical dimensions as the temperature is raised and lowered. The former reaction results in dripping walls and scouring of the brick at operating temperatures, while the latter condition causes the brick to crumble, bulging walls, etc.

If the alumina be exceedingly high, other difficulties are introduced. Whereas excess of silica results in a few mineral combinations, alumina in excess combines more readily into many more different types of minerals. The chief advantage of excess alumina is that the resulting combinations are more stonelike in character; that is, the glassy matrix is absent. When brought to its softening point, the formation is more viscous and less likely to deform. The absence of the glass formation means greater resistance to spalling. On the other hand, refractories with excess of silica may be given higher mechanical loads right up to the melting point. The failure on rising temperature is sudden, whereas with excess alumina the failure by slipping under mechanical load is not at one definite temperature range, but begins gradually and increases at a more rapid rate as the temperature rises.

The disadvantage of excess alumina is that unless the refractories have been burned to 2,500 deg. F. or higher in firing, the shrinkage that will develop in boiler furnace operation will disrupt the walls. Excess of silica, on the other hand, results in glassy fragile walls subject to spalling. These remarks refer to an excess of either component over that necessary to satisfy the alkalies and accessory minerals. The addition of accessory minerals and alkalies to grog of high silica or alumina content to prevent an excess of either

is often practiced in some metallurgical arts where suitable clays are not available at reasonable cost. The alkalies are the strength-imparting components of the refractory, and if present in insufficient quantity the result is tender brick.

Kaolin is the clay combination of the best refractoriness because it is well balanced and neutral to outside influence. The nearer a fireclay brick approaches to kaolin, the better the brick for boiler furnace conditions. It is a combination having the ratio of one part alumina to two parts silica, or 45.8 per cent alumina and 54.2 per cent silica. Most fireclay brick approach quite closely this ratio.

For most dependable service, unless other factors indicate differently, any selection of fireclay refractories by chemical analysis should be done on the basis that the percentage of silica should be higher than that of alumina or at least equal to it. No brick should be considered where the silica is greater than 65 per cent. Any brick outside these ratios would be a gamble unless other and complete data were available, concerning both the furnace itself and the manufacture of the refractory.

As long as the softening point determination shows the refractoriness to be in excess of 3,000 deg. F., the amount of alkali is not important, except that the more alkali the greater the binding power of the particles and the greater the mechanical strength.

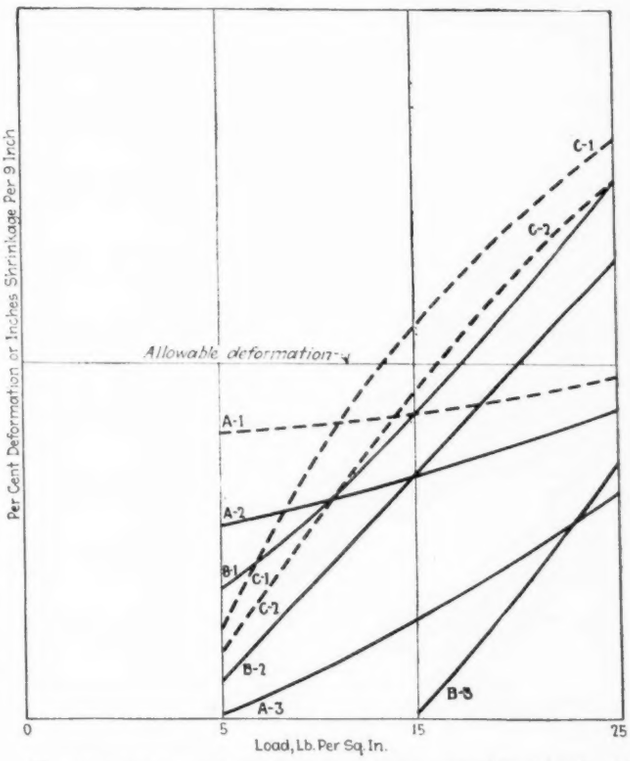
Aside from these general considerations nothing more can be told from the chemical analysis. Therefore specifications should be written so as not to set any hard and fast limits on silica, alumina or alkalies. Under no conditions should the selection of refractories for boiler furnace work be made on softening-point determinations and chemical analysis unsupported by other considerations.

Deformation Under Load

Such a test was devised to measure comparative refractoriness and to determine the probable stability of a furnace built of the tested brick. As generally conducted, this test is simple and gives comparative figures that are useful to the expert. Although there is danger in using this test as a means for selecting brick, with certain modifications from the standard for different conditions, it is probably the best means available for comparing refractories.

Deformation is a load-temperature-time function. As a consequence, unless the entire range of the function within the bounds under which it is intended to use the brick is considered, the test is meaningless. The determination for a single load is likewise meaningless because the trend of the deformation is not evident. Any specification for the selection of refractories by this test should be explicit as to deformation trend rather than seek to set a single maximum of deformation; or the load, temperature and time elements should be selected with regard to the purpose of the test. With correctly selected time and temperature conditions and a series of tests made at different loadings, a curve may be plotted to show the trend. If the tests are made at, say, two temperatures, each at three or more loads, a graph may be drawn that will give a clear idea of the relative value of each refractory tested.

A graph of such deformation tests is shown in the accompanying illustration. The deformations are plotted in per cent shrinkage or in inches of shrinkage per 9 in. as ordinates, and the load as abscissas. It is best to select a series of loads such that the middle one will represent the average load to be placed on the refractories in service. Then select another load higher and one lower. On the graph the samples have been designated by letters, *A*, *B* and *C*, and the temperatures at which the tests were carried out by numbers 1, 2 and 3. Assume that a small furnace is being built where the load on the heaviest portion of the wall will not exceed 5 pounds per square inch and that conditions are such as to anticipate an average temperature of 2,500 deg. (indicated by 1), such as might be the case for the party wall between two boilers, both operating and under heavy firing. It is evident that brick *C*-1 would be the most satisfactory under these conditions. This brick would be thrown out if the test were carried



Typical deformation tests on three samples (A, B, C) at three temperatures (1, 2,500 *deg. F.*; 2, 2,300; 3, 2,000) *and under three loads* (5, 15 *and* 25 *lb.*).

out at a loading of 25 lb. per sq.in., as indicated, because the deformation is greater than the specifications would allow.

On the other hand, if the height of the wall were such that the load at some critical part of the furnace came up to 25 lb., then *A*-1 would be the brick to select. At 15-lb. loading brick *A*-1 or *B*-1 could be used, although the preference would be in favor of *B*-1. Here again the best brick for the service would be disqualified if the specifications called for standard loading as at 25 lb. It is evident, then, that the specifications must select the maximum shrinkage allowable, not at any standard load and temperature, but under the most severe conditions likely to occur in practice.

Ordinarily, deformation does not become a factor in wall stability except in party walls, because the average temperature of the walls is low on account of dissipation of heat from the exterior. Below 2,000 deg. F. little deformation occurs unless the refractory be of unusually poor manufacture. The mean temperature

through boiler furnace walls seldom reaches this figure except where they are over-insulated or the walls are exceptionally thick. Of course the party wall in a battery does get up to these temperatures all the way through as the heat is applied to both sides and there are only the small areas at the base, ends and top for dissipation.

The Test for Spalling

The spalling test is conducted usually by the alternate heating and cooling of the end of the sample. The cooling is done either by a blast of air or by dipping the sample in water. Neither of these methods is quite suited to tests of refractories for boiler furnaces. Although taking much less time, the dipping in water is unusually severe, since the cooling is more rapid than in actual service and takes place along the sides as well as at the ends. Under these conditions the cooling sets up stresses at a greater distance from the face, causing a greater loss to the sample when pieces break off.

An alternate test that is just as quick and gives results more like those obtained in service is to build the samples into a test wall, as is done in the simulative service test of the Navy. The furnace is then heated up in the regular manner and a finely atomized spray of water is introduced just as the fuel oil was sprayed. The spraying is continued for five minutes, allowing an equal period without spray for the water to evaporate, and then the firing is resumed. This is an accelerated test to simulate several months of firing service and consequently must be used with judgment. The limits should be broad enough not to bar any but the specimens that are away below average.

For large pieces no suitable test ever has been devised. Here the location in the fire has more to do with the pieces than any other one factor. For tests of mixtures for such large pieces, it is best to make up samples in standard firebrick size and then use a great deal of judgment in interpreting the test results.

The simulative service test was devised to determine the value of refractories for marine service. As a consequence the furnace is oil-fired. It will be found in practice that brick for oil-fired units usually are not suited for coal firing; that coal-fired, natural-draft furnaces demand different brick from those for forced-draft units pushed to the limit. For these reasons the Navy simulative service test should be used with caution in selecting brick for coal- or gas-fired units.

Torch Solves Difficult Piping Problems

BY MARTIN VANDERVEER
Chief Engineer, Hygienic Ice Co., New Haven, Conn.

ALTHOUGH the ice plant of which the writer is chief engineer is but a few years old, growth of the business made necessary the installation of additional ammonia compressors and generating sets. The present equipment includes two 150-ton constant-speed, and one 120-ton variable-speed uniflow-engine-driven ammonia compressors and three uniflow-driven generating sets, two horizontals of 50 and 100 kw. and one vertical four-cylinder 250-kw. set.

All these units exhaust into a pair of surface condensers designed to maintain a 26-in. vacuum in average summer weather, the circulating water for steam and ammonia condensers being handled by a large cooling tower on the roof. This tower is so arranged, that during hot weather it is split up in two separate towers, one for the steam condenser and one for the ammonia condenser. In cooler weather it operates as a single large tower, water first running over the ammonia condenser and from there, through the steam condensers and circulating pumps, back to the tower.

Ahead of the steam condensers in the original installation was a 15-in. vacuum separator. While this was ample for the plant as originally planned, the additional refrigerating and generating capacity installed

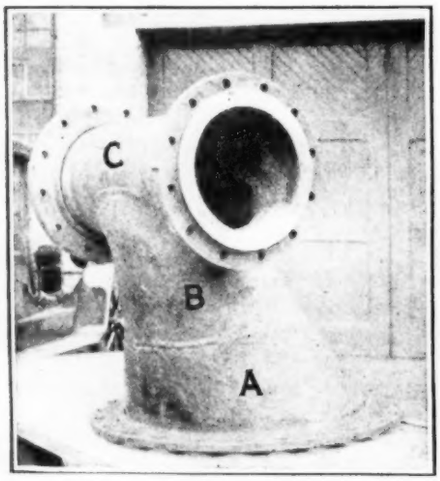


Fig. 1—Special skew tee connects separator to condensers

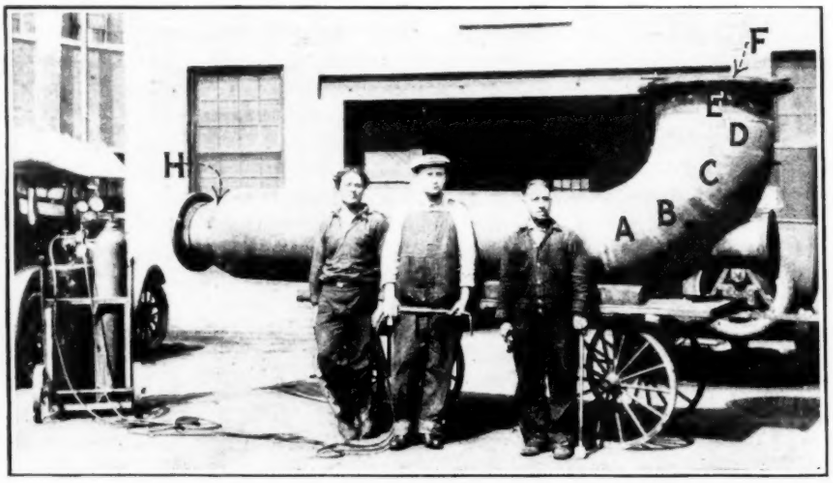


Fig. 2—Connection leading up to separator was fabricated by the men in the plant

made the steam velocities too high for proper operation. The amount of steam to be handled called for a 26-in. separator, the guarantee on which demanded at least ten feet of 26-in. main ahead of the separator. The pipe work and erection were done by our own force in the following manner with the aid of the oxyacetylene torch.

How the Inlet Connection Was Made

For the inlet connection (Fig. 2) five short sections of 26-in. pipe (*A*, *B*, *C*, *D*, *E*) were cut off on the bias, shaped in the forge and then acetylene-welded to complete the elbow. A 26-in. Van Stone joint *F* and 10-in. nozzle (at *B*) were welded on.

The lower end of the pipe was tapered down from 26 in. to 21 in. A piece of the 16-in. line with Van Stone joint was cut off and opened up to 21 in. to match the taper. The two sections were then welded together at the point *H*.

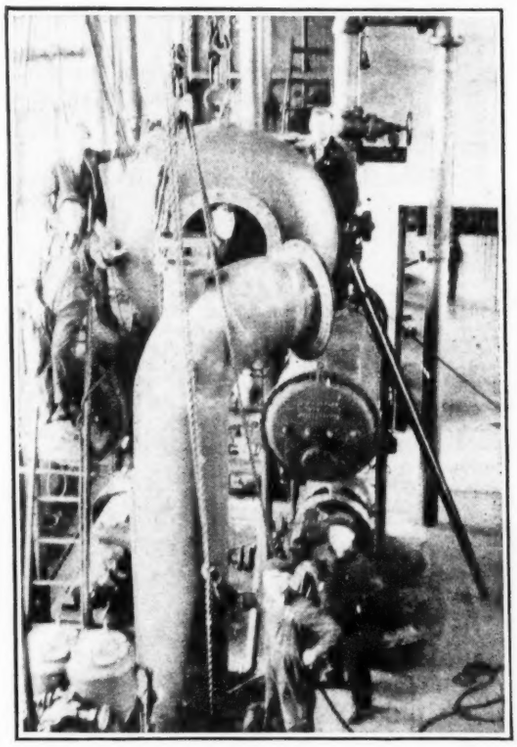


Fig. 3—Erecting separator and connections. Separator is above two condensers

As the distance from the outlet of the separator to the center of the condenser inlets was only 28 in., a very close connection was required. For this purpose the special tee shown in Fig. 1 was made as follows: A second short 26-in. Van Stone joint *A* was tapered down to 21 in. and off-centered. A piece of 16-in. pipe *B* was opened up to 21 in. on one end and cut out on the other end to fit a 12-in. crosspiece *C* which was 30 in. long and Van Stoned on both ends. After those operations the sections were assembled and welded as shown.

The parts were then erected. A test showed only two pinholes, which we think is remarkable considering the size and number of joints. Naturally, everyone felt proud of his share in the work. This job, incidentally, shows why a welding outfit is becoming a necessity in the power plant.

Suggestions on Diesel Maintenance

By James M. Bloomfield

From a considerable experience with steam and internal-combustion engines the writer believes that the maintenance of a Diesel engine is not more exacting than that required for steam plants of equal power; in fact, many parts that require care and maintenance are common to all prime movers. The object of overhauling any engine is to ascertain the condition of certain parts, particularly those requiring an unusual amount of time to remove and get to during the period between overhauls, and to clean, readjust, renew and, generally speaking, to make the engine reliable and free from compulsory stops when again on duty.

All possible data should be collected, such as measuring the wear of bearings, liners, pins, bushings, etc., and these should be logged for comparison at each subsequent overhaul.

During the week before the overhaul, notes should be made while the engine is running, of various parts requiring renewing and attention, such as links, slack and worn plungers, lubricator adjustments and rocker arms, so that these minor, yet important, details are not overlooked during the general overhaul. Before the engine is shut down, indicator diagrams should be taken to ascertain particularly the compression pressure of each cylinder, as this is of first importance to successful running. If the engine is fitted with exhaust pyrometers, a careful record should be made of the working temperature of each cylinder at some rated load of the engine, preferably three-quarters to full load.

The cause of any discrepancy should be carefully looked for, such as rings not free in the grooves, rings too slack in the grooves, the joints of the rings having worked all to the same side of the piston, etc. The rings should also be taken off the piston and put into the liner to measure the gap at that point; if this is more than about $\frac{1}{8}$ in. at the smallest diameter of the liner, the ring should be renewed. The pyrometer records will show possible leaks in inlet or exhaust valves and the state of the fuel valves. Before dismantling the engine, the crankshaft should be given particular attention. The more important points to be considered are:

1. Is the shaft being properly supported in its bearings?
2. Are the bearings in a satisfactory condition?
3. Are all the bearings including the outboard bearing or bearings, in alignment with each other?

One of the first indications of the shaft's being imperfectly supported in its bearings is the excessive end play on the shaft, with the flywheel running out of truth. The play is produced by the springing of the crankshaft for want of support, and actually the shaft is being extended and contracted in length by the opening and closing of the gap between the crank webs.

Sometimes Equipment Is Installed and never used. This not only ties up capital, but also takes up valuable space. It shows ignorance of actual operating conditions. Instances are not rare of ventilating fans being installed and seldom used. In one industrial power plant they even put in a condenser and vacuum pumps and never used the apparatus from the day of its acceptance test. There was too much use for exhaust steam.—*F. H. Randolph.*

Engineering Tables of Properties of New Refrigerants*

THE recent developments in the production of the hydro-carbon gases of the paraffin series, butane, isobutane, propane and ethane, have opened up possibilities of their extended use as refrigerating agents. The advent of small refrigerating machines for industrial and other uses has created a demand for refrigerants having low pressures, but the properties of these fluids have been known only uncertainly. As a result of recent researches engineers now may know the characteristics of most of the refrigerants.

Concerning the accuracy with which these data should be determined, there are two viewpoints—one the use of the data in refrigerating engineering and the other the use as physical constants. From the latter point of view the highest precision would no doubt be desirable, but the work would require a number of years for completion. From the engineering viewpoint an accuracy of one or two per cent is considered sufficient in good engineering practice. It should be emphasized that in the use of these gases as refrigerants such disturbing influences as traces of air, water vapor, lubricants and other factors enter to make the properties of the gas tested slightly different from an absolutely pure sample. In this investigation the researchers attempted to determine the data with an accuracy within one per cent, some being determined more accurately and besides the utility of the results in engineering they will be found of value in physical research.

The experimental observations on butane, isobutane and propane have been combined into an equation of the form

$$\log p = a + \frac{b}{T} + 1.75 \log T + cT$$

in which the pressure p is expressed in atmospheres absolute, and the temperature T in deg. C absolute. To solve for the three constants, a, b and c, requires three experimental points for each substance. While it is perhaps true that an equation of the form above does not hold all the way from the boiling point to a critical point, nevertheless for the range of these experiments it held within the experimental error, 0.5 per cent; and the agreement was generally much better. The constants are as follows:

	a	b	c
Butane	1.75680	-1337.8	-0.004070
Isobutane	1.00856	-1164.4	-0.002990
Propane	0.53787	- 956.44	-0.0023108

From the tables it will be observed that butane offers lower condenser pressures than do the other two refrigerants. It, however, possesses the disadvantage of requiring low suction pressures if low evaporating temperatures are to be obtained. In this respect isobutane is superior to butane and at the usual household refrigerator temperature its suction pressure can be above atmospheric.

TABLE I—PROPERTIES OF BUTANE

Temp. Deg. F. t	Pressure lb. per sq. in.		Specific Volume cu. ft. per. lb.		Density lb. per cu. ft.		Heat Content B.t.u. per lb.		Latent Heat, B.t.u. per lb. L	Entropy B.t.u. per lb. Deg. F.		Temp. Deg. F. t
	Absolute p	Gauge $g.p.$	Liquid v	Vapor V	Liquid $1/v$	Vapor $1/V$	Liquid h	Vapor H		Liquid s	Vapor S	
0	7.3	*15.0	0.02591	11.1	38.59	0.0901	0	170.5	170.5	0.000	0.371	0
5	8.2	*13.2	0.02603	9.98	38.41	0.100	2.5	172.0	169.5	0.006	0.370	5
10	9.2	*11.1	0.02615	8.95	38.24	0.112	5.5	174.0	168.5	0.011	0.370	10
15	10.4	* 8.8	0.02627	8.05	38.07	0.124	8.0	176.0	168.0	0.017	0.371	15
20	11.6	* 6.3	0.02639	7.23	37.89	0.138	10.5	177.5	167.0	0.022	0.370	20
25	13.0	* 3.6	0.02651	6.55	37.72	0.153	13.0	179.0	166.0	0.028	0.371	25
30	14.4	* 0.6	0.02664	5.90	37.54	0.169	16.0	181.5	165.5	0.033	0.371	30
35	16.0	1.3	0.02676	5.37	37.37	0.186	19.0	183.5	164.5	0.039	0.371	35
40	17.7	3.0	0.02689	4.88	37.19	0.205	21.5	185.0	163.5	0.044	0.371	40
45	19.6	4.9	0.02703	4.47	37.00	0.224	24.5	187.0	162.5	0.050	0.372	45
50	21.6	6.9	0.02716	4.07	36.82	0.246	27.0	188.5	161.5	0.056	0.373	50
55	23.8	9.1	0.02730	3.73	36.63	0.268	30.0	190.5	160.5	0.061	0.373	55
60	26.3	11.6	0.02743	3.40	36.45	0.294	33.0	192.5	159.5	0.067	0.374	60
65	28.9	14.2	0.02759	3.12	36.24	0.321	36.0	194.5	158.5	0.072	0.374	65
70	31.6	16.9	0.02773	2.88	36.06	0.347	38.5	196.0	157.5	0.078	0.375	70
75	34.5	19.8	0.02789	2.65	35.86	0.377	41.5	198.0	156.5	0.083	0.375	75
80	37.6	22.9	0.02805	2.46	35.65	0.407	44.5	199.5	155.0	0.089	0.376	80
85	40.9	26.2	0.02821	2.28	35.45	0.439	47.5	201.5	154.0	0.094	0.376	85
86	41.6	26.9	0.02825	2.24	35.40	0.446	48.5	202.0	153.5	0.095	0.376	86
90	44.5	29.8	0.02838	2.10	35.24	0.476	51.0	203.0	152.0	0.100	0.377	90
95	48.2	33.5	0.02854	1.96	35.04	0.510	54.0	205.0	151.0	0.105	0.377	95
100	52.2	37.5	0.02870	1.81	34.84	0.552	57.0	206.5	149.5	0.111	0.378	100
105	56.4	41.7	0.02889	1.70	34.62	0.588	60.5	208.5	148.0	0.117	0.380	105
110	60.8	46.1	0.02906	1.58	34.41	0.633	63.5	210.5	147.0	0.122	0.380	110
115	65.6	50.9	0.02925	1.48	34.19	0.676	66.5	212.0	145.5	0.128	0.381	115
120	70.8	56.1	0.02945	1.38	33.96	0.725	70.0	213.5	143.5	0.134	0.382	120
125	76.0	61.3	0.02966	1.30	33.72	0.769	73.5	215.5	142.0	0.139	0.382	125
130	81.4	66.7	0.02986	1.21	33.49	0.826	76.5	217.0	140.5	0.145	0.384	130
135	87.0	72.3	0.03009	1.14	33.23	0.877	80.0	219.0	139.0	0.151	0.385	135
140	92.6	77.9	0.03032	1.07	32.98	0.934	83.5	221.0	137.5	0.157	0.386	140

*Inches of mercury below one standard atmosphere (29.92 in.)

*Tables of properties reproduced were presented before the American Society of Refrigerating Engineers at Chicago, Ill., June 3, 1926, by L. I. Dana, A. C. Jenkins, J. N. Burdick and R. C. Trimm.

TABLE II—PROPERTIES OF ISOBUTANE

Temp Deg. F t	Pressure lb. per sq. in. Absolute p	Pressure lb. per sq. in. Gauge $g.p$	Specific Volume cu. ft. per. lb. Liquid v	Specific Volume cu. ft. per. lb. Vapor V	Density lb. per cu. ft. Liquid $1/v$	Density lb. per cu. ft. Vapor $1/v$	Heat Content B.t.u. per lb. Liquid h	Heat Content B.t.u. per lb. Vapor H	Latent Heat, B.t.u. per lb. L	Entropy B.t.u. per lb. Deg. F. Liquid s	Entropy B.t.u. per lb. Deg. F. Vapor S	Temp. Deg. F. t
—20	7.50	*14.6	0.02610	10.5	38.35	0.0952	—9.0	156.5	165.5	—0.020	0.356	—20
—15	8.30	*13.0	0.02620	9.90	38.15	0.101	—7.0	157.0	164.0	—0.015	0.354	—15
—10	9.28	*11.9	0.02635	8.91	37.95	0.112	—4.5	168.5	163.0	—0.010	0.353	—10
— 5	10.4	* 8.8	0.02645	7.99	37.80	0.125	—2.5	159.5	162.0	—0.005	0.351	— 5
0	11.6	* 6.3	0.02660	7.17	37.60	0.139	0	160.5	160.5	0.000	0.350	0
+ 5	13.1	* 3.3	0.02675	6.41	37.40	0.156	+2.5	162.0	159.5	0.005	0.348	+ 5
10	14.6	* 0.2	0.02690	5.75	37.20	0.174	5.0	163.5	158.5	0.011	0.348	10
15	16.3	1.6	0.02705	5.18	37.00	0.193	7.5	164.5	157.0	0.016	0.347	15
20	18.2	3.5	0.02715	4.68	36.80	0.214	10.0	166.0	156.0	0.021	0.346	20
25	20.2	5.5	0.02730	4.24	36.60	0.236	13.0	167.5	154.5	0.027	0.346	25
30	22.3	7.6	0.02745	3.86	36.40	0.259	15.5	169.0	153.5	0.032	0.346	30
35	24.6	9.9	0.02760	3.52	36.20	0.284	18.0	170.5	152.5	0.038	0.346	35
40	26.9	12.2	0.02780	3.22	36.00	0.311	21.0	172.0	151.0	0.044	0.346	40
45	29.5	14.8	0.02795	2.96	35.80	0.338	24.0	174.0	150.0	0.049	0.346	45
50	32.5	17.8	0.02810	2.71	35 60	0.369	27.0	175.5	148.5	0.055	0.346	50
55	35.5	20.8	0.02825	2.49	35.40	0.402	30.0	177.5	147.5	0.061	0.347	55
60	38.7	24.0	0.02840	2.28	35.20	0.439	33.0	179.0	146.0	0.067	0.348	60
65	42.2	27.5	0.02855	2.10	35.00	0.476	36.5	181.0	144.5	0.073	0.349	65
70	45.8	31.1	0.02875	1.94	34.80	0.515	39.5	183.0	143.5	0.079	0.350	70
75	49.7	35.0	0.02890	1.79	34.60	0.559	43.0	185.0	142.0	0.086	0.351	75
80	53.9	39.2	0.02910	1.66	34.35	0.602	46.5	187.0	140.5	0.092	0.352	80
85	58.6	43.9	0.02930	1.54	34.10	0.649	50.0	189.0	139.0	0.098	0.353	85
86	59.5	44.8	0.02935	1.52	34.10	0.658	50.5	189.5	139.0	0.099	0.354	86
90	63.3	48.6	0.02950	1.42	33.90	0.704	53.5	191.0	137.5	0.105	0.356	90
95	68.4	53.7	0.02965	1.32	33.70	0.758	57.5	193.5	136.0	0.112	0.358	95
100	73.7	59.0	0.02990	1.23	33.45	0.813	61.0	195.5	134.5	0.118	0.359	100
105	79.3	64.6	0.03005	1.14	33.25	0.877	65.0	198.0	133.0	0.125	0.360	105
110	85.1	70.4	0.03030	1.07	33.00	0.935	69.0	200.0	131.0	0.132	0.362	110
115	91.4	76.7	0.03050	0.990	32.80	1.01	73.0	202.5	129.5	0.139	0.364	115
120	98.0	83.3	0.03075	0.926	32.50	1.08	77.0	204.5	127.5	0.147	0.367	120
125	104.8	90.1	0.03095	0.867	32.30	1.15	81.5	207.5	126.0	0.154	0.369	125
130	112.0	97.3	0.03125	0.811	32.00	1.23	86.0	210.0	124.0	0.161	0.371	130
135	119.3	104.6	0.03145	0.760	31.80	1.32	90.5	212.5	122.0	0.169	0.375	135
140	126.8	112.1	0.03175	0.716	31.80	1.32	95.0	215.5	120.5	0.176	0.377	140

*Inches of mercury below one standard atmosphere (29.92 in.).

TABLE III—PROPERTIES OF PROPANE

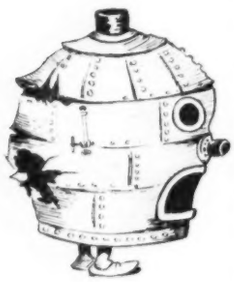
Temp. Deg. F. t	Pressure lb. per sq. in. Absolute p	Pressure lb. per sq. in. Gauge $g.p.$	Specific Volume cu. ft. per. lb. Liquid v	Specific Volume cu. ft. per. lb. Vapor V	Density lb. per cu. ft. Liquid $1/v$	Density lb. per cu. ft. Vapor $1/v$	Heat Content B.t.u. per lb. Liquid h	Heat Content B.t.u. per lb. Vapor H	Latent Heat, B.t.u. per lb. L	Entropy B.t.u. per lb. Deg. F. Liquid s	Entropy B.t.u. per lb. Deg. F. Vapor S	Temp. Deg. F. t
—75	6.37	*17.0	0.02660	14.5	37.59	0.0690	—39.5	151.0	190.5	—0.092	0.404	—75
—70	7.37	*14.9	0.02674	12.9	37.40	0.0775	—37.0	152.5	189.5	—0.086	0.400	—70
—65	8.48	*12.7	0.02688	11.3	37.20	0.0885	—34.5	153.5	188.0	—0.080	0.397	—65
—60	9.72	*10.1	0.02703	9.93	37.00	0.111	—32.0	155.0	187.0	—0.074	0.393	—60
—55	11.1	* 7.3	0.02717	8.70	36.80	0.115	—29.0	156.5	185.5	—0.067	0.391	—55
—50	12.6	* 4.3	0.02732	7.74	36.60	0.129	—26.5	158.0	184.5	—0.061	0.389	—50
—45	14.4	* 0.6	0.02748	6.89	36.39	0.145	—24.0	159.0	183.0	—0.055	0.386	—45
—40	16.2	1.5	0.02763	6.13	36.19	0.163	—21.5	160.0	181.5	—0.049	0.384	—40
—35	18.1	3.4	0.02779	5.51	35.99	0.181	—19.0	161.0	180.0	—0.042	0.382	—35
—30	20.3	5.6	0.02795	4.93	35.78	0.203	—16.0	163.0	179.0	—0.036	0.380	—30
—25	22.7	8.0	0.02811	4.46	35.58	0.224	—13.5	164.0	177.5	—0.030	0.378	—25
—20	25.4	10.7	0.02827	4.00	35.37	0.250	—11.0	165.0	176.0	—0.024	0.377	—20
—15	28.3	13.6	0.02844	3.60	35.16	0.278	— 8.0	167.0	175.0	—0.018	0.375	—15
—10	31.4	16.7	0.02860	3.26	34.96	0.307	— 5.5	168.0	173.5	—0.012	0.374	—10
— 5	34.7	20.0	0.02878	2.97	34.75	0.337	— 2.5	169.5	172.0	—0.006	0.372	— 5
0	38.2	23.5	0.02895	2.71	34.54	0.369	0	170.5	170.5	0.000	0.371	0
+ 5	41.9	27.2	0.02913	2.48	34.33	0.403	+ 3.0	172.0	169.5	+0.006	0.370	+ 5
10	46.0	31.3	0.02931	2.27	34.12	0.441	5.5	173.5	168.0	0.012	0.370	10
15	50.6	35.9	0.02950	2.07	33.90	0.483	8.5	175.0	166.5	0.018	0.369	15
20	55.5	40.8	0.02970	1.90	33.67	0.526	11.0	176.0	165.0	0.024	0.368	20
25	60.9	46.2	0.02991	1.74	33.43	0.575	14.0	177.5	163.5	0.030	0.368	25
30	66.3	51.6	0.03012	1.60	33.20	0.625	17.0	179.0	162.0	0.035	0.366	30
35	72.0	57.3	0.03033	1.48	32.97	0.676	20.0	180.5	160.5	0.041	0.366	35
40	78.0	63.3	0.03055	1.37	32.73	0.730	23.0	182.0	159.0	0.047	0.366	40
45	84.6	69.9	0.03078	1.27	32.49	0.787	26.0	183.5	157.5	0.053	0.365	45
50	91.8	77.1	0.03102	1.18	32.24	0.847	29.0	185.0	156.0	0.059	0.365	50
55	99.3	84.6	0.03125	1.10	32.00	0.909	32.0	186.5	154.5	0.065	0.365	55
60	107.1	92.4	0.03150	1.01	31.75	0.990	35.0	188.0	153.0	0.070	0.364	60
65	115.4	100.7	0.03174	0.945	31.50	1.06	38.0	189.5	151.5	0.076	0.364	65
70	124.0	109.3	0.03201	0.883	31.24	1.13	41.0	190.5	149.5	0.082	0.364	70
75	133.2	118.5	0.03229	0.825	30.97	1.21	44.0	192.0	148.0	0.088	0.364	75
80	142.8	128.1	0.03257	0.770	30.70	1.30	47.5	193.5	146.0	0.093	0.364	80
85	153.1	138.4	0.03287	0.722	30.42	1.39	50.5	195.0	144.5	0.099	0.364	85
86	155.3	140.5	0.03292	0.717	30.38	1.40	51.0	195.0	144.0	0.100	0.364	86
90	164.0	149.0	0.03317	0.673	30.15	1.49	54.0	196.5	142.5	0.105	0.364	90
95	175.0	160.0	0.03348	0.632	29.87	1.58	57.0	197.5	140.5	0.111	0.364	95
100	187.0	172.0	0.04481	0.591	29.58	1.69	60.5	199.0	138.5	0.116	0.363	100
105	200.0	185.0	0.03416	0.553	29.27	1.81	63.5	200.0	136.5	0.122	0.364	105
100	187.0	172.0	0.03381	0.591	29.58	1.69	67.0	201.0	134.0	0.128	0.363	110
115	226.0	211.0	0.03493	0.488	28.63	2.05	70.5	202.0	131.5	0.134	0.363	115
120	240.0	225.0	0.03534	0.459	28.30	2.18	73.5	202.5	129.0	0.140	0.363	120
125	254.0	239.0	0.03575	0.432	27.97	2.31	77.0	203.5	126.5	0.145	0.361	125

*Inches of mercury below one standard atmosphere (29.92 in.).

Views of Some Exploded Boilers

What a Boiler Inspector Thinks a Convention of Exploded Boilers Might Say—Man Deserves a Little Credit but a Deal More of Blame—Loss Due to Carelessness More Than Appalling

THE graveyard of exploded boilers was becoming entirely popular. Each night when the ghosts of such departed pressure vessels met, the crowded condition became more and more evident. Even the sage of the place, a bewhiskered spirit of a Boulton & Watt haystack boiler, complained that a lot of new-fangled boiler ghosts were encroaching upon his place, which he had held in fee simple since 1798. Something must be done to keep down the rising population, and one ghost, who rather felt he would shine even in Congress, declared for an investigation committee to report back recommendations as to how to keep down "The Rising Tide" of exploded boilers. As is usual, he received the office of chairman with well-simulated surprise. Seating himself on a broad stone in memory of a well-respected steam-hoist boiler who had literally been driven to death by careless engineers, the chairman opened the first meeting of the Investigating Committee of The United Boiler Spirits.



"Gentlemen," so spoke the chairman, "we must have a purpose. What shall we say is the underlying purpose of this investigation? I call on your Grandpappy Boulton to set us right."

"I suggest that we are here for the promotion of safety and economy and to get inside information on the subject of boiler explosions and the cause of them."

"That, Pappy, is well put; it should look well in print. Now we, speaking editorially, will have each one that we call on, relate the real facts of misfortune that brought him here, that we may analyze them and prescribe remedies to reduce the waste of property and the sacrifice of human life."

"Things are worse than when I was a boy," the Boulton & Watt ghost complained. "It seems the younger generation, while it may not be 'flaming youth,' is surely the 'exploding youth.' Are there not many cities and states that have rules, regulations, codes and laws with compulsory inspection as means toward conservation of life and property?"

"There are but twenty-one states and some cities having boiler regulations," the chairman answered conciliatorily, "and we are at a loss to know why every state in the Union does not do its part toward protecting its citizens by having intelligent boiler laws.

"I think," he continued, "that a good reason for calling this gathering, besides the desire to keep down our ghost population, is the fact that in the United States alone for the period of five years including 1920 to 1924 the total number of explosions was 3,560—an average of two for every day in each of the five years. In the five years 698 people were killed by these explosions. Every time the clock ticked away 62½ hours one person was killed by steam boilers.

"In addition," he continued, waxing warmer, "In the five-year period 1,490 persons were injured by boiler explosions, averaging 298 per year; including the killed and injured persons, the total of 2,188 averages 1.2 for every day of the five years. From present indications 1926 bids fair to keep up the record.

"We have gathered here tonight, the remains of many an exploded boiler, and will expect each one called upon to tell without fear or favor the cause and the nature of the explosion, also the extent of the damage done and how to prevent similar explosions. Beginning at the back row, I call upon the first party on the left. Let us hear what you have to say for yourself."

This party, the ghost of a straight-tube vertical water-tube boiler well made and about 18 years old, arose. Speaking somewhat modestly, he said, "I was used in a steel plant, was taken off for cleaning and was again put under fire for service. The weather was cold and the safety valve was frozen and inoperative. I was not connected with the other boilers and being subjected to overpressure, exploded, causing the loss of three lives and personal injury to twelve."

Said the chairman, "This is a case when neither yourself nor your maker was at fault. Evidently, the frozen valve was due to someone's carelessness. Now let us hear from the next specter."

Ghost No. 2 began speaking even before he arose. "I was a horizontal water-tube boiler of the water-leg type, used in an electric-power plant. They allowed the water to get too low, causing overheating and explosion. Seven lives were lost, nineteen persons were injured and the property waste was over $50,000."

The old Boulton & Watt specter exclaimed, "Ignorance or carelessness causes the death of seven human beings, bringing misery and suffering to their families and friends; and injury and suffering to nineteen others. It is a pitiful cry for education among engineers and boiler attendants. Things are as bad as in my day."

The chairman, striving to control the meeting, turned to a third, saying, "Give us the particulars of your failure."

The one addressed, confessed with some pride that he had been a popular make of boiler and the main part of the boiler did not explode, but a cast-iron mud drum let go causing the death of five men and injury to three.

"Why did this drum explode?" the chairman asked.

"Cast iron is a metal of very uncertain quality, and after being subjected for years to the stresses caused by the changes of temperature and pressure, it grows in volume, loses strength and is liable to failure," put in a modern-looking specter. "Drums made of steel are far safer and of longer life."

Addressing No. 4 ghost, the chairman said, "I recall that your explosion caused the loss of four lives and the great waste of property to the extent of over $100,000."

"That's true," conceded the ghost, "although I was of the bent-tube type of water-tube boiler, well built and was used in a good-sized electric-power plant: I received proper care, but exploded from a disease described as grooving and fatigue of metal caused by the breathing action of a drum head."

"Why should the head breathe or move and cause this fatigue of metal and grooving?"

"The design of my head was not in accordance with the best practice; it should have been heavier or not so flat in shape."

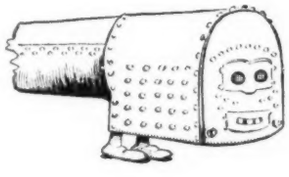
The fifth specter, when his turn came, stated that he had been a vertical water-tube boiler located in a steel plant, only 17 years old and one of two auxiliary boilers. His explosion was caused by overpressure, as the fire was lighted about one hour and the attendants were of the opinion there was only 50 lb. steam pressure when the explosion occurred, but the nature of the explosion indicated overpressure. Seven lives were lost and 36 persons injured.

"Well, why should they believe there was only 50 lb. pressure when there was sufficient to blow up the boiler. How were they deceived?"

"The steam gage may have been defective," No. 5 explained, "or the pipe leading to it clogged and the safety valve not in good working order."

"No. 6, let us hear from you; we must hurry if all are to testify."

"I was not a boiler but an economizer, serving as a storehouse of energy operated in connection with steam. Briefly, I will speak for myself and two of my kind that exploded in a period of five years. On one the outlet valve was closed and excessive temperature created, one exploded by overpressure, which was permitted by improper arrangement of valves. The third was wasted by corrosion."



"Your report indicates that economizers should be protected by safety valves and have a frequent inspection, and further, three explosions in five years is a high percentage considering the number of economizers in use. Let us have the next witness."

"I was a lap-seam horizontal return-tubular boiler used in a sawmill in the sunny South. My explosion caused two other boilers to explode, entailing the death of eight persons and the injuring of ten."

"Give the attributed cause of your failure."

"Fatigue of metal in a cast-iron steam-outlet flange; the fatigue was caused principally by vibration of the steam line. The initial failure was in the top plate and my body was torn into many parts. The shock caused the explosion of the other two boilers and the destruction of the plant."

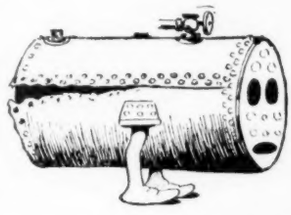
"Your report indicates the importance of preventing vibration in steam pipes, and the value of steam boiler laws and rules to prevent the use of cast iron in certain parts of power boilers. But we must hustle; we will hear from the eighth specter."

"I was the boiler of a standard-gage locomotive," explained No. 8. "After being used four years some repairs and a hydrostatic test were made."

He continued, "The safety valves were ground in for tightness, and when steam was raised, the valves seemed to blow too early and were screwed down. Full dependence was placed on the steam gage, and in the endeavor to have the safety valves relieve at a certain pressure, the springs were set too high and the pressure soon became sufficient to explode the boiler."

"I was a boiler of the well-known horizontal return-tubular type," testified No. 9 in his turn. "About 15 years old. I was operated at a fair factor of safety and received proper attention by way of cleaning and repairs. I was just being placed in service after being off for minor repairs when the explosion happened; thirteen employees were killed and about forty injured. I served in a rolling mill and the explosion did great property damage, causing considerable loss of time. The explosion was caused by water hammer."

"Tell us—what is this water hammer?"



"Water hammer is the violent action of water in a steam pipe, boiler or other vessel. The entrained water of condensation, if allowed to collect in a steam pipe, continues to increase in quantity until there is not sufficient space to permit the steam to pass over it, then it is forced into action and all the water is carried forward with great violence by the steam. It travels like a cannon ball through the pipe and in many cases ruptures the pipe or fittings.

"Water hammer in a steam boiler is caused by the sudden opening of a valve or breaking of a connection. The very sudden release of pressure above the water causes a violent ebullition in the water, as all the energy stored in the water seeks release at once when the sudden opening takes place. This action throws the water in the boiler up against the top with such force that rupture often takes place."

"We are to understand that opening a valve too suddenly may cause water hammer and explosion of either a boiler or steam pipe?"

"Yes, and water hammer has caused the loss of many lives and great property damage."

"No. 10, what is your history?"

"I was a horizontal water-tube boiler about 18 years old when I was taken out of service for cleaning. I was washed out and fired up at 11 p.m. At 2 a.m. I exploded, causing the loss of three lives, injury to two and the loss of over $60,000 in property, all by neglect to keep sufficient water."

"Stenographer, charge this loss to carelessness. No. 11, your report."

"I was of the horizontal firebox type, and used in an ice plant in the East; my explosion killed seventeen

people, injured fifteen others and shattered me into about fifty pieces. One piece weighing several hundred pounds was blown one-eighth mile from the plant."

"And the cause of this loss?"

"About the same as No. 8, a defective gage and a safety valve screwed down. But far worse, I was a second-hand boiler several times over. I was about 40 years old and was wasted in places by corrosion. The gage became defective and was supposed to have been repaired by a plumber. The gage was still defective and the engineer, not knowing this, tried to make the safety valve agree with the defective gage; dangerous overpressure and explosion resulted."

"I was a horizontal return-tubular boiler 14 years old, having what is known as a lap-seam construction," reported No. 12. "I operated at not over 90 lb. steam pressure, received average good care, but finally exploded, causing a loss of 58 innocent lives and the injury of 117 others. Many of those killed and injured were women and girls."

"What caused the explosion? Tell us!"

"A lap crack in the longitudinal seam caused the initial failure, followed by a very complete explosion, tearing and ripping the plates apart and scattering them and the tubes over a wide area."

"What is a lap crack and are they numerous?"

"Lap cracks are frequently found along the longitudinal joints of lap-seam boilers. The boiler shell is slightly out of round at this point, and the expansion and contraction of the shell plate causes a bending movement which in time starts minute cracks that later join each other, forming a long continuous crack if not detected in time."

"If not detected in time, you say? Can they be detected in time?"

"Yes, in recent years a chief engineer of one of the boiler-insurance companies has devised and patented a plan of slotting the plates in a manner that will greatly assist in detecting these hidden cracks, and thereby greatly reduce explosions."

"Can this dangerous feature of boilers be eliminated entirely in some manner?"

"The nearest to elimination is the butt and strapped joint, on which it is possible to develop cracks, but they are extremely rare."

"I was built for 100 lb. working pressure, "spoke up No. 13, "and later as a heating boiler carried but a few pounds pressure. Unfortunately, there was a stop valve under the safety valve and you know when a safety valve is out of order, stuck, or blocked off, sufficient firing will surely raise the pressure to the danger point. Heating boilers often explode from this very cause."

"Is there a remedy?"

"Regular and careful inspection by trained inspectors and intelligent instructions to attendants would reduce this class of explosions considerably."

"Can much damage be done by an explosion if only low pressure is carried?"

"Surely. The energy stored in the heated water and steam when released very suddenly will cause damage, and low-pressure boilers contain great volumes of water and steam which, if suddenly released, may cause loss of life and property damage just as in case of power boilers."

"Enough for tonight! You have reported the death of many people, the personal injury of many more. The replacement of the same property today would cost several millions. It is made clear by the evidence given that there will always be boiler explosions, but most of them could be prevented by observance of sensible instructions such as are to be found with little difficulty. There is entirely too much taking chances among engineers. If one must commit suicide let him do it by means other than by boiler neglect."

"The following resolution has been made, and if no objections are raised it will be made a part of the report:

Let it be resolved and broadcasted to all safety engineers:

1. That engineers in charge of boilers should have more practical education in the care of steam boilers.
2. That safety valves should not be placed where they may be made inoperative by freezing.
3. That boilers should not be forced to the extent of causing low water and overheating.
4. That all parts of boilers should be open to inspection.
5. That no one should be permitted to tamper with a safety valve unless he has permission from his boiler inspector.
6. That boiler inspectors should be compelled to make hammer tests in all cases where complete inspection is being made.
7. That hydrostatic tests are to be encouraged on new boiler work and on old and wasted boilers, but not to be considered sufficient in any case.
8. That old lap-seam boilers should be subjected to special inspections at frequent intervals.
9. That second-hand boilers be viewed with a critical eye and subjected to thorough inspection before permission is granted for their use.
10. That not only twenty-one states but each and every state should be a party to a consistent uniform boiler law.
11. That all inspectors, whether in the employ of city, state, or national government, for railroad or marine service, or insurance companies, be men with steam-boiler experience and have special training to enable them to make inspections of the highest quality.

"The lesson of this night," concluded the chairman, "should be broadcasted to every engineer and boiler user. The message should make clear that low- as well as high-pressure boilers explode and destroy life and property; that the most modern boiler can be exploded if proper precautions are not taken; that engineers and boiler attendants should be educated and impressed with the importance of proper care and attention to steam boilers, and that eternal vigilance is the price of safety."

THE RATING AT WHICH A BOILER can be operated depends primarily upon the amount of coal that can be burned upon the grate, and this is determined by the size of the grate and the draft available. The limit is reached when the draft will bring no more air through the fuel bed or when an excessive amount of labor, involving an expense too high for practical operation, is required to keep the fuel bed in condition for air to get through. As pointed out before, the practice of expressing the performance on the basis of per cent boiler rating developed is not accurate, since the rate of combustion of fuel on the grate for any given per cent boiler rating developed depends upon the size of the grate.—*Bulletin No. 26, Purdue University.*

CONSULTING ENGINEERS FOR AVON PLANT—McClellan & Junkersfeld were consulting engineers for the Cleveland Electric Illuminating Company in the design and construction of the recently opened new Avon plant. This information was inadvertently left out of the article on this plant in the Sept. 28 issue.

Basel Conference Gives Much Attention to

Steam and Hydro-Electric Plant Interconnection

By R. H. ANDREWS
Paris Representative of *Power*

AFTER eight days devoted to the presentation of technical papers and reports, and to other activities, the first sectional meeting of the World Power Conference, held at Basel, Switzerland, was brought to a close on Wednesday morning, Sept. 8. In last week's issue a report of the first seven sessions was given. The following presents a digest of the last four sessions, which were devoted to a discussion of the economic relations between the production of electric energy hydraulically and thermally and the conditions under which the two methods can be combined advantageously.

Power generation is an outstanding economic problem in Europe. This was made evident by the nature of the papers presented at the closing sessions of the conference. How the problem is to be handled varies greatly with the country and its resources of fuel and water power.

Interconnections of steam and water-power plants under various conditions; interconnections of run-of-river plants with hydro-plants having storage facilities; interconnection of hydro-electric plants on one river with plants on another river, to make possible taking advantage of the differences in high-water periods of the two rivers; and the use of industries that can absorb large blocks of intermittent power so as to adopt the demand to the available power supply—these were among the proposals made for the more advantageous use of power resources.

Another proposal was the use of steam accumulators on systems having interconnected steam and water-power plants. On such a system the boilers would operate at a constant load and the accumulator and the steam turbines would take the load fluctuations. By this means the stand-by losses, which are always high in a steam plant used for peak-load service, are reduced to a minimum.

Although much of the power in Sweden is supplied from water, it was pointed out that almost all of the distribution systems have steam or Diesel stations to handle the peak loads. Interconnections of the water-power stations and providing water-storage facilities have done much to improve the power supply from water-power plants. At present the average annual load factor of the hydro-electric plants in Sweden is about 68 per cent.

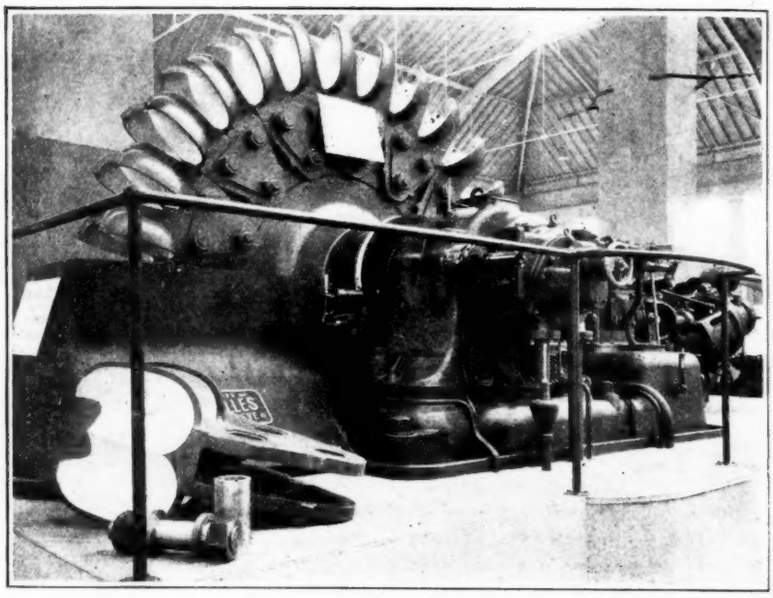
It was suggested that the cost of generation of power for peak-load service by means of Diesel engines is practically independent of the cost of fuel and is more advantageous than storage-water power, where the period of use is less than 2,000 to 2,500 hours per year. The advantage was given as being even more in favor of the Diesel over storage water in the case of stand-by plants for emergency and dry-year service. Furthermore, the Diesel plant of small capacity may be installed at or near the center of power demand, such as in cities or in large industrial plants. Owing to the easy starting of this type of engine, stand-by losses are practically non-existent.

The opinion was expressed that instead of building stand-by steam stations in Switzerland and importing high-grade fuel for their operation, it would be more advantageous to import electric energy from stations located in the neighboring countries, for example, from the lignite fields of the Rhineland.

This suggestion naturally brings up the question of interchange of power between different countries, to which two sessions of the conference were devoted. This is a vital matter to Switzerland, for the export of power gives promise of becoming one of that country's chief sources of revenue. At the present time Switzerland exports 20 per cent of its total power generated, and future hydro-electric developments will depend to a considerable extent on the possibilities of marketing the energy in neighboring countries. The introduction of a tariff on export power is an important question. This, however, is not a technical problem, but a special phase of economics and world trade and is closer to international law than to engineering.

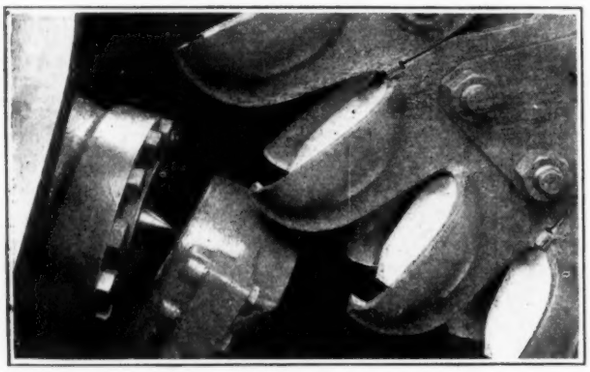
From an analysis of the different factors entering into the production costs of power generated in low-head run-of-river plants, high-head storage plants and steam plants in France, conclusions were presented to the effect that in France the balance between the cost at the point of utilization, of electrical energy generated by water power and that generated by steam power, is reached for an annual usage of 4,000 hours for the water-power station, if it is 60 miles away from the load; and for an annual usage of 5,800 hours if the water-power plant is 300 miles away from its load. The opinion was also expressed that in France no hydro plant should be built until it is assured of a market for at least 60 per cent of its energy as soon as it goes into service. It is therefore advisable that any expansion be provided for with a steam plant until the load is sufficient to absorb at least 60 per cent of a new hydro-plant's capacity.

Attention was called to the rapid extension of hydro-electric development in Italy, resulting from the scarcity of fuels. At present there are 1,911,000 kw. of water power and 481,000 kw. of steam station capacity installed. The principal sources of energy are the Alps, characterized by abundance of power in summer and scarcity in winter; the Apennines, where there is high water in winter and low water in summer; and steam plants, many of which operate on lignite and peat. The combination of these sources is favorable to the production of electrical energy.



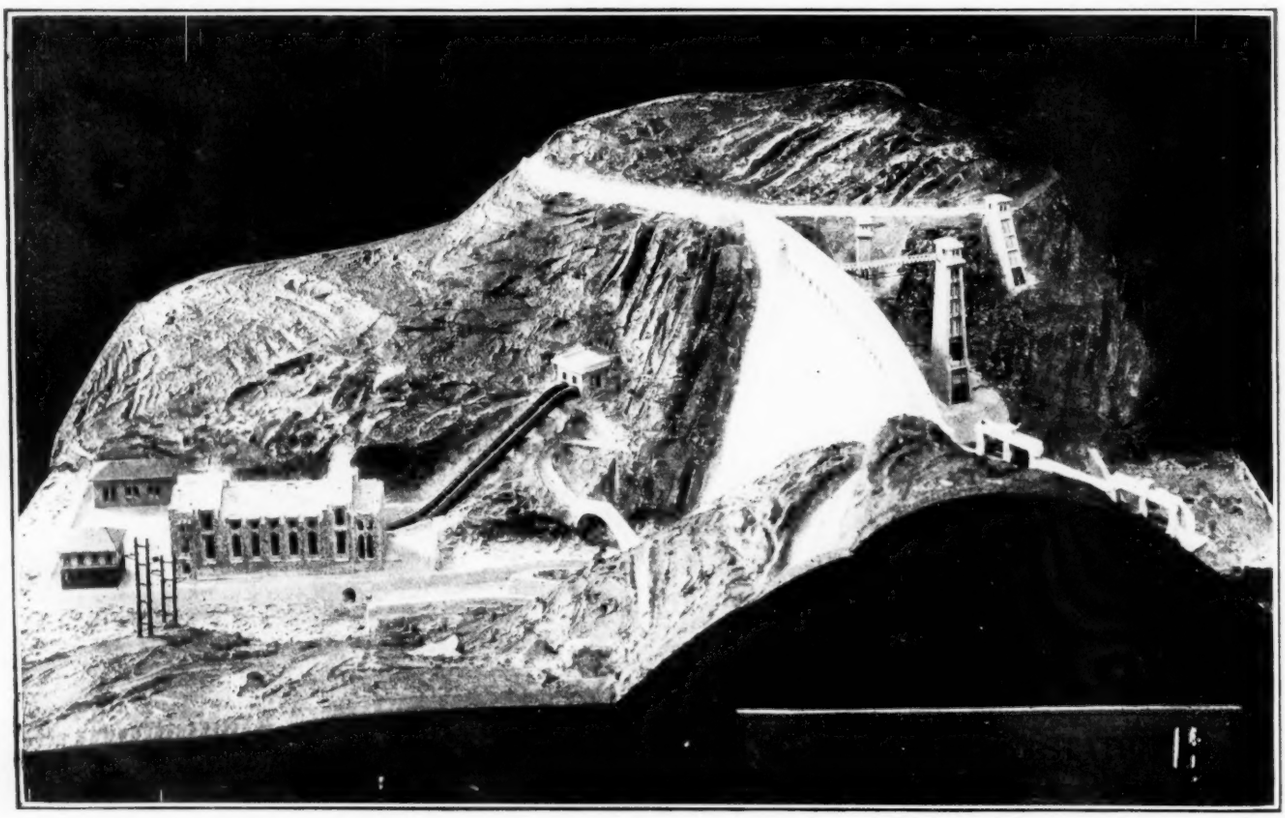
Right—A 20,000-hp. Pelton type water-wheel to operate at 333 r.p.m. under a 2,100-ft. head, built by the Ateliers de Charmilles, Geneva, for the Vernayaz station of the Swiss Federal Railways. This unit was set up in Machinery Hall at the Exhibition.

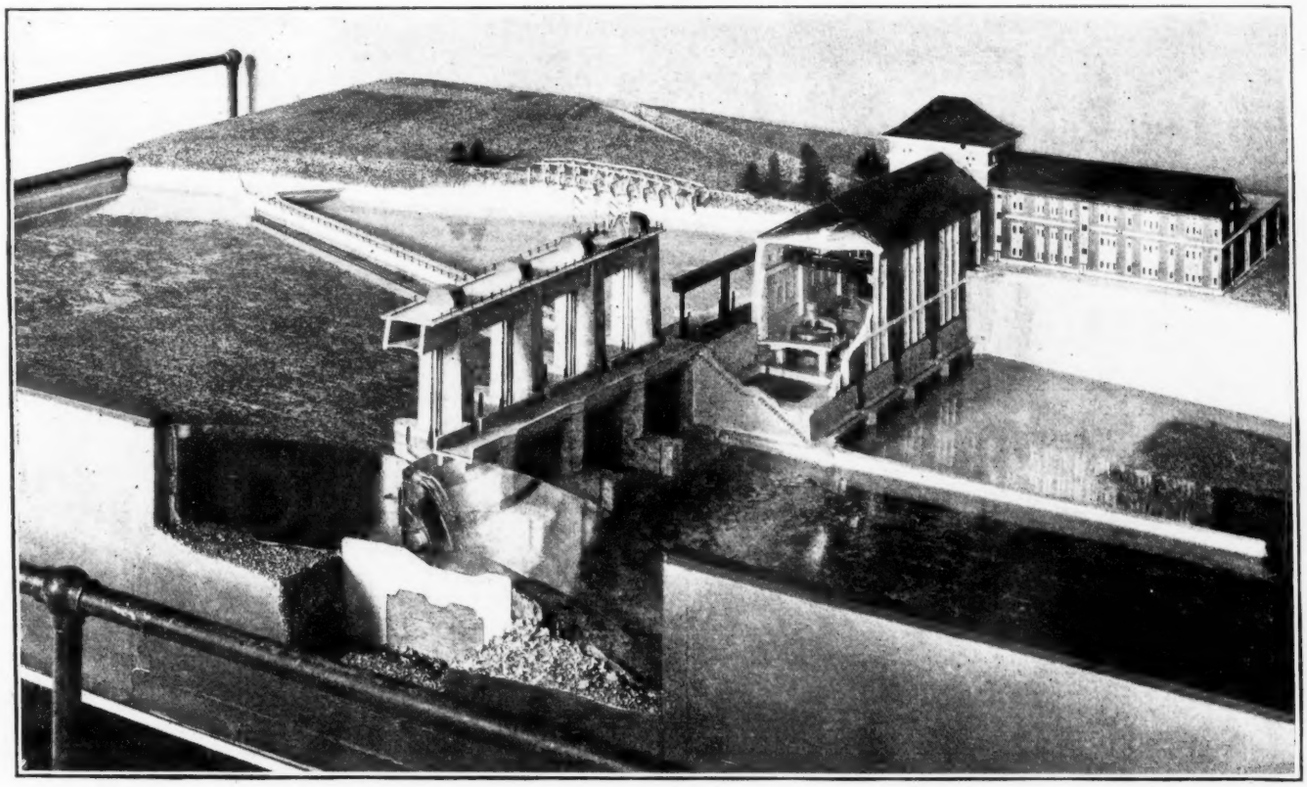
Below—A close-up view of the buckets and nozzle. In front of the nozzle at the left can be seen the jet deflector used to assist in governing the unit.

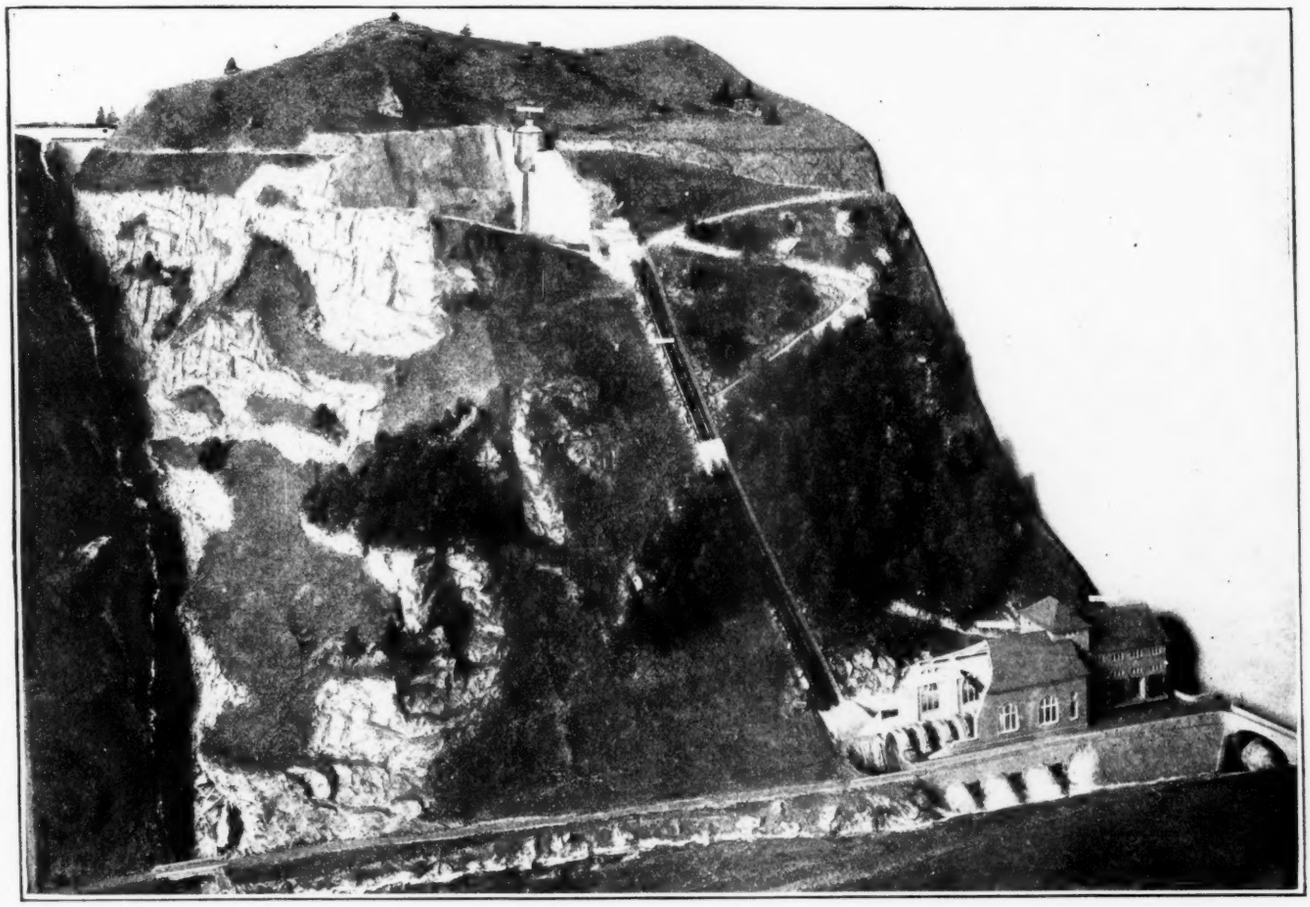


Some of the Exhibits Shown at the Basel Exposition of Inland Navigation and Water Power

Below—Model of a water-power development, exhibited by the Transportation Division of the Italian government. In the center is the dam, over the top of which a roadway is built. To the right of the dam are the intakes which form the entrance to the tunnel that leads the water to a gatehouse on the side of the mountain below the dam.







Power-House Models Exhibited by the City of Basel

Top—Model of low-head plant. Sluice gates are in the center foreground. Sections of sluiceway retaining wall and of the power house cut away to show their construction and operation. Bottom—Model of high-head water-power development. Water is brought through a tunnel from a reservoir, in the upper left-hand corner.

*Boiler Feed-Water Purification—XVI**

Deconcentrators and Continuous Blowdown

Blowdown Does Not Necessarily Mean Waste. Read How Suspended Solids May Be Removed from Boiler Water and How Boilers May Be Blown Down Continuously with Little Loss of Heat

By SHEPPARD T. POWELL
Consulting Chemical Engineer, Baltimore, Md.

CONCENTRATION of soluble or suspended solids in boilers must be controlled in order to prevent priming and foaming and scale formation. This is commonly done by blowing down. The frequency of blowing down and the amount of water discharged at each blowdown vary greatly. In the majority of the smaller plants and in many large installations the blowdown cycle is a rule-of-thumb procedure. Such methods are inefficient and result in too few or too many blowdowns. In the first instance scale formation and moisture in the steam may become excessive. Blowing down too often results in excessive makeup, waste of heat and other unnecessary losses.

How Losses May Be Reduced

There are at least three ways in which these losses may be reduced:

1. Treatment of the feed water outside the boiler by means of evaporators (thus removing practically all solids from the water) or by chemicals with partial reduction of scale-forming solids.

2. Removal of a portion of the suspended solids from the water blown from the boiler and returning the water to the boiler without an appreciable loss of heat.

3. Blowing down continuously a small volume of water and utilizing the heat released from the blowdown to preheat the feed water.

In the present chapter only the last two methods will be considered, since external treatment of feed water has been previously described.

The "deconcentrator" shown in Fig. 1 was designed to prevent accumulations of suspended solids in the boiler. This is accomplished by passing a small portion of the boiler water continuously through the apparatus and preventing any loss of water by returning the filtered blowdown to the boiler. The equipment is actually a small pressure filter through which the boiler water is passed continuously while the boilers are in operation. The coarser suspended solids that have been thrown out of solution in the boiler under the influence of heat or by chemical treatment, are strained out by the filter[1] medium.

The apparatus is under boiler pressure, but a small pump is necessary to overcome the friction of the piping system and filter medium. When the filter becomes clogged by deposits removed from the water, the unit is cut out of service and washed by reversal of the flow of water, as is done in other types of pressure filters.

Referring to Fig. 1, the boiler water enters the top of the apparatus (indicated by the arrows) and passes downward through the filter material. The clarified water passes from the bottom directly to the pump, which discharges it back into the boiler. When sufficient material has collected on the surface of the filter to prevent the desired rate of filtration, the unit is cut out of service by closing the valves on the inlet and outlet lines. Wash water is then passed upward through the bed. The filter medium may be agitated by means of a manually operated paddle. The accumulated suspended solids are discharged to waste through the "wash outlet." At the conclusion of the washing period the apparatus is again put into service by closing the wash-out valves and opening the valves on the boiler line and the effluent line connected with the pump.

The efficient functioning of this system in respect to scale prevention in the boiler depends upon converting the soluble calcium and magnesium salts into insoluble compounds and removing them from the boiler before they can deposit and bake upon the tubes. Some of the earlier installations of this kind did not accomplish the desired results owing to the fact that calcium sulphate deposited on the tubes and sheets of the boiler before precipitation occurred in the main body of the water.

R. E. Hall, in studying these conditions, showed by experimental studies that calcium sulphate formed on the metal of the boiler because the solubility of this salt decreased as the temperature increased, resulting in sulphate scale formation even though no appreciable amount of calcium sulphate was thrown out of solution

*Previous installments have covered the following subjects: July 6, "Natural Waters and Their Impurities"; July 13, "Getting Rid of Impurities by Sedimentation and Coagulation"; July 20, "Filtration by Gravity and Pressure Filters"; July 27, Softening Water by Chemicals"; Aug. 3, "riot Process Continuous Softeners"; Aug. 10, "Zeolites Explained"; Aug. 17, "Where Zeolites Fit In"; Aug. 24, "Boiler Compounds"; Aug. 31, "Priming and Foaming"; Sept. 7, "Embrittlement—What Causes It"; Sept. 14, "Evaporators, Their Design and Operation"; Sept. 21, "Getting Rid of Dissolved Gases by Deaëration"; Sept. 28, "Corrosion—Its Cause and Cure."

[1]The filter material is a non-siliceous compound. Sand or other siliceous substances are not well suited to this service, since some hot alkaline solutions react with silica, forming dense hard scale.

in the main body of the water in the boiler. As a result of this study it was found necessary to employ internal treatment by sodium salts to convert the sulphate into carbonate or phosphate, the carbonate or phosphate precipitate being removed by the deconcentrator.

The apparatus is an ingenious means of utilizing the boiler temperature to throw scale-forming solids out of solution and to remove them by filtration, reducing heat losses as a result of less frequent blowdown. Sodium and other soluble salts are not removed by the deconcentrator, but continue to build up in the boiler. The

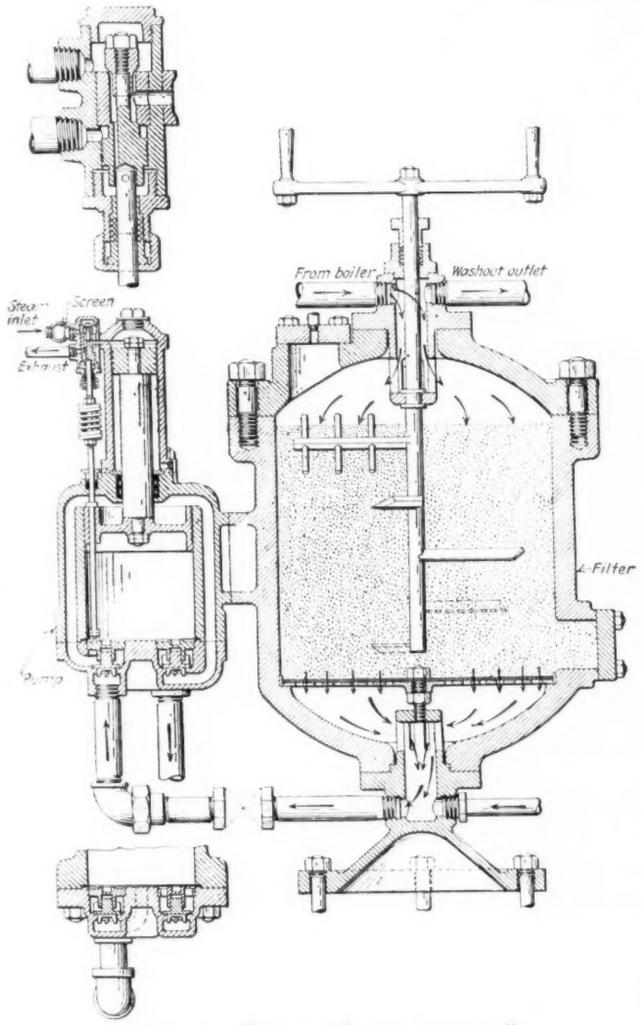


Fig. 1—Hagan "Deconcentrator"

boiler water must be changed when these salts become highly concentrated.

The system is comparable to a hot chemical softener in which the reaction chamber is the boiler and the deconcentrator the pressure filter. The precipitation of the carbonates is effected by heat alone, while in a hot-process chemical softener lime is added to assist in precipitation of the calcium and magnesium salts. The efficiency of the equipment for inhibiting suspended solids is indicated by the typical curves shown in Fig. 3.

It is highly desirable to remove scale-forming material from feed water by external treatment if possible. The less solids entering the boiler the fewer will be the difficulties from scale and sludge. Where external treatment is not practiced, conversion of the sulphates into insoluble carbonates or phosphates and removal of these salts by blowing down without loss of heat has merit. With proper control and suitable conditions the system may lessen scale formation and reduce also the corrosive properties of the water. The advantages and

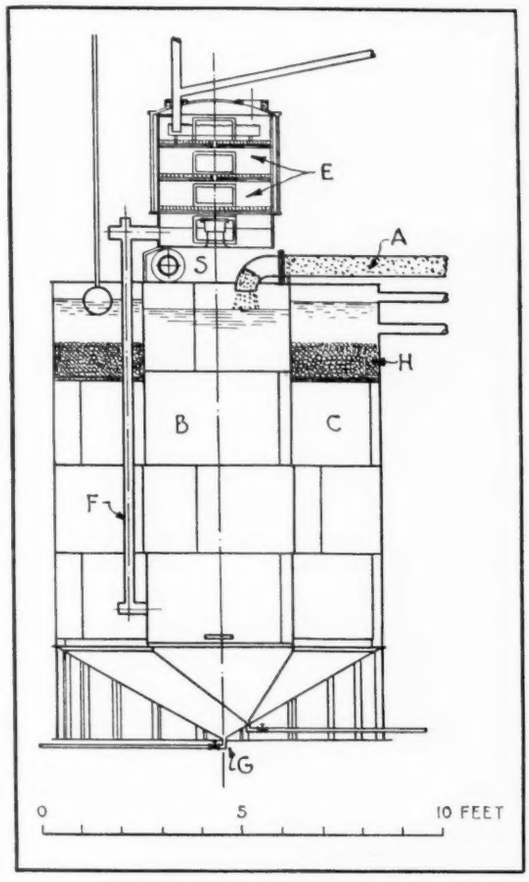


Fig. 2—Hot-process softener designed to utilize water from continuous blowdown

disadvantages of the system may be summarized briefly as follows:

ADVANTAGES

1. Small space required and relatively low initial cost of installation and operation.
2. Partial saving in heat of blowdown water.
3. Reduction of suspended solids in the boiler water with a smaller loss of heat than when blowdown water is wasted.
4. Possible reduction in blowdowns.
5. Higher concentration of sodium salt than could be safely maintained with higher suspended solids.
6. Reduction of total volume of scale and partial inhibition of corrosion under some conditions.

DISADVANTAGES

1. Necessity for internal treatment. Chemical treatment is generally carried on satisfactorily outside of the boiler.
2. Necessity of frequent back washing when the feed water contains much suspended matter or has a high calcium or magnesium content.
3. Relatively high rates of filtration necessary, resulting from the small effective filter area and the volume of water that must be passed through the unit in a given period, under some conditions.

4. Increasing operating difficulties in the maintenance of a series of filters and pump, when installed on a number of boilers, in place of one central treating plant.

Continuous Blowdown

Numerous schemes for blowing down boilers have been devised in order to limit the concentration of solids with as little loss of heat as possible. The continuous blowdown method has been given considerable attention recently and a number of appliances have been devised. As the terms indicate, continuous blowing down consists in discharging relatively small amounts of water at a constant rate in place of the intermittent blowing down as commonly practiced. The advantage gained by this method of operation is (a) utilization of the heat from the blowdown water for useful work and return of the water to the boiler after removal of solids; (b) constant removal of the solids from the boiler water as they are thrown out of solution.

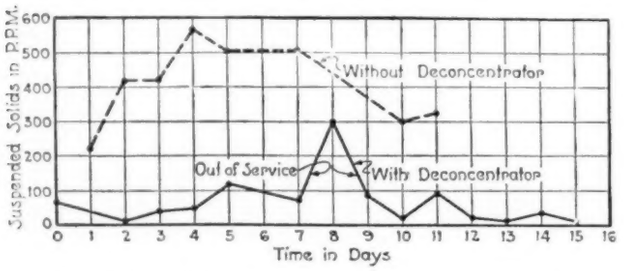


Fig. 3—Suspended solids from two steam boilers, one with and one without deconcentrator

The general arrangement of a type of continuous blowdown and softening apparatus, widely used in Europe, is shown in Fig. 2. Water is blown continuously from the boiler through the line *A*, emptying into the center chamber *B*. The suspended solids settle in this compartment, while the supernatant liquor[2] is decanted into compartment *C*. The steam released from the blowdown water serves to heat the incoming water in the heater *E*. Soda ash or other softening chemicals are applied to the water as it enters this heater. The partly heated water flows into compartment *C* through pipe *F*, where it mixes with the clarified blowdown water. In the upper portion of the tank is a shallow filter *H*, through which the water is clarified by upward filtration. It is then pumped back into the boiler. When the filter becomes fouled, it is washed by reversing the flow of water. The solids are discharged into compartment *C* whence they may be removed by blowing down through line *G*. A continuous blowdown softening system of this general type, but somewhat modified, is in operation at the Gennevilliers Central Station, Paris.

A recently developed system of continuous blowdown is shown in Fig. 4. By the use of this equipment the water blown from the boiler is utilized to heat the feed water. The water is drawn from the upper portion of each drum of the boiler and the blowoff is so arranged in the drum that the level of the water in the boiler is not permitted to be reduced to a point below the usual low-water line.

A continuous stream of the concentrated boiler water is discharged at a fairly constant rate through the heat exchanger. From here it passes through the blowoff control box and thence into the sewer. In passing through the heat exchanger, the heat from the blowdown water warms the incoming raw makeup. In this way most of the blowdown heat is returned to the boiler. The heat exchanger, which is practically a closed heater, consists of a cast-iron shell with bolted flanged heads through which pass helical copper coils. Leakage is prevented by stuffing glands in the heads of the heat exchanger. There are individual coils for each boiler and likewise a control or weir box connected with each coil. By this means the water blown from each boiler may be controlled independently of the other units.

The blowoff control weir box consists of an open steel tank with an adjustable opening in the bottom. The constant head of water in the box over the weir opening is maintained by a float valve on the inlet side, which discharges water from the coil of the heat exchanger.

The continuous blowdown method for controlling suspended and soluble solids in boilers should be studied by operating engineers. There are a number of advantages to be gained from this system which may do much to correct difficulties from priming, foaming and scale formation. The principal reason for limiting the amount of water blown from boilers is the economic losses resulting from the waste of heat. Where it is possible to extract the heat and utilize it for useful

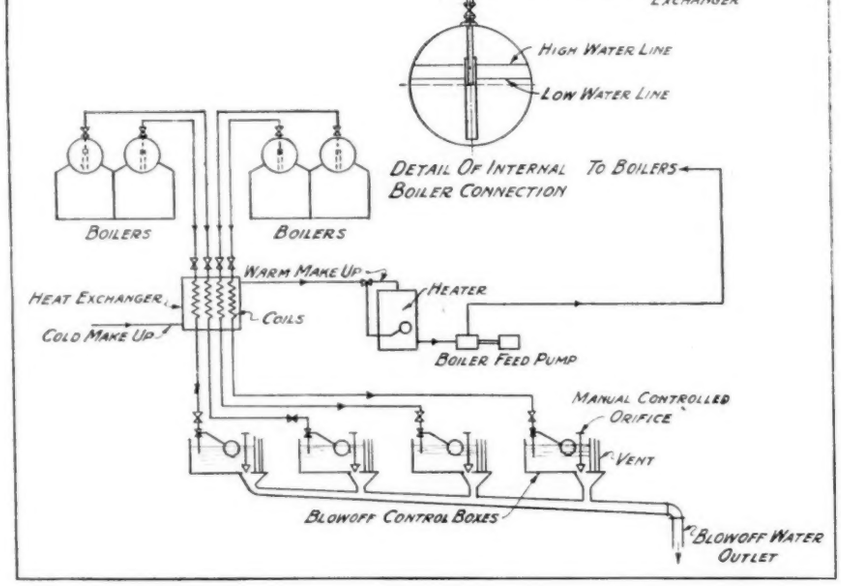


Fig. 4—General arrangement for the continuous blowing down of boilers, with utilization of heat for feed heating (Permutit system)

[2] That is, the water near the surface, which is relatively free from sludge.

work, the percentage of blowdown may be materially increased with no great fuel loss.

In continuous blowdown systems where the suspended solids only are removed, advantages are not so great as where none of the boiler water is returned. Wasting all the blowdown water after the heat has been exhausted from it, is, under most conditions, a preferable arrangement.

One of the difficulties to be anticipated in a continuous blowdown system is the erosion and wear of valves and controlling appliances. With water free from suspended solids the depreciation of equipment in this respect should be relatively slight. Where suspended solids are present, however (especially silica, grit and other hard material), the wear may be excessive. The most important advantage to be gained from this system is the control of soluble solids and finely divided suspended matter which is thrown out of solution in the boiler. Under these conditions the system has particular application to boilers in which the makeup water has been treated externally and in which the majority of solids concentrating in the boiler are sodium salts.

There are several ways in which the heat of the blowdown water may be utilized to advantage. In the case where external treatment is by evaporators or base exchange substances (zeolites), the makeup may be warmed by the heat released from the blowdown water. Where hot lime-soda softeners or lime-and-barium softeners are used, the blowdown water passing through a heat exchanger may serve to heat the water on its way to the softener.

The economic advantages to be gained by the system will depend, of course, upon the heat balance of the station. In the case of systems where there is a deficiency of exhaust steam, continuous blowdown appliances have a particular sphere of usefulness, since the heat extracted from the blowdown water may serve in one or more ways for feed-water heating, as has been indicated. Continuous blowing down of boilers should not replace the regular blowdown valves, since even with these appliances in use, regular blowing down may be desirable or necessary.

Apparent Advantages Summarized

The apparent advantages from this form of boiler-water control may be summarized as follows:

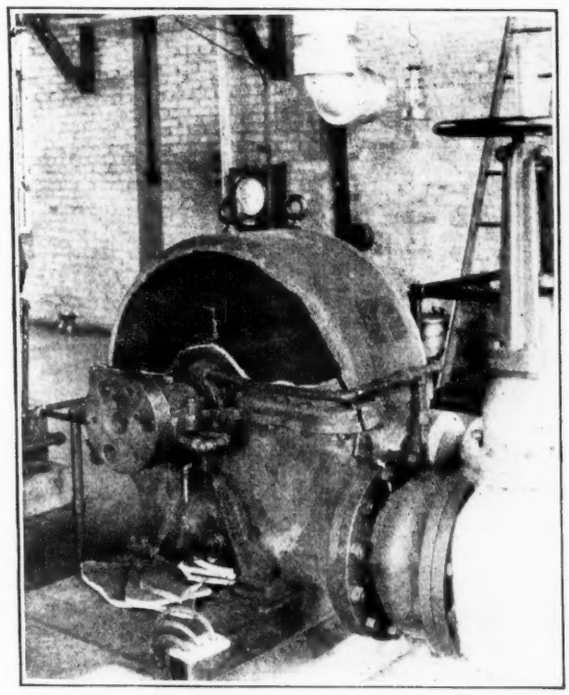
1. It permits maintaining a fairly uniform concentration of suspended and dissolved solids in the boiler, reducing the possibility of priming and foaming and sometimes reducing the scale and sludge.
2. Where the system is designed to heat the feed water, marked economy may be effected either in the pretreatment of the makeup or in the operation of some forms of external treatment.
3. When properly designed and operated, a more uniform concentration of solids may be maintained than by intermittent blowing down. This is more apparent where the load on the boilers fluctuates over wide ranges.
4. Better circulation in many instances may be obtained by continuously blowing down than by opening the blowdown valves at predetermined periods.
5. Great differences in temperature between the bottom and top of the mud drums may be avoided by this method.

Any study pertaining to the installation of a continuous blowdown system should include also the possible reduction which may be effected by removal of the majority of solids from the raw makeup water by external treatment.

Blowing down of boilers is an important item in efficient plant control which deserves careful consideration from operators. It should be done at sufficiently frequent intervals to maintain the soluble and suspended solids below a predetermined concentration. The most efficient method of control in this respect is to determine by analysis of the boiler water, the safe maximum limit of dissolved salt concentration and so to regulate the blowdown cycle or the amount of water passed through the continuous system as to maintain a fairly uniform condition of the boiler water.

Turbine Wreck Due to Closing Wrong Valve

IT IS NOT unusual to find a stop valve located in the exhaust pipe between a small turbine and the condenser. This arrangement is invariably due to the fact that other units exhaust into the same condenser, so it would not be possible to unhouse one turbine with the others in operation unless there was some means of separating the turbine from the condenser.



The exhaust valve (right) was mistaken for a throttle. This is the result

An atmospheric relief valve intended to protect the condenser as well as the turbines from excess pressure usually is located near the condenser, and the exhaust line stop valve may be between the turbine and the atmospheric relief valve. With such an arrangement the turbine casing may be subjected to boiler pressure in case the exhaust-line stop valve is closed.

Manufacturers of small single-stage turbines, with few exceptions, have followed the plan of designing the casings so that they will withstand boiler pressure, but

the turbines having two or more stages are constructed with thinner walls, as the possibility of high pressure decreases, so the exhaust end of a multiple-stage turbine should not be subjected to more than 10 or 15 lb. pressure.

The turbine casing may be provided with a small signal relief valve which is intended to act as an alarm in case the cooling water fails and pressure builds up in the condenser, but that relief valve is not of sufficient capacity to prevent excess pressure in the casing if there were no other means of relief. Hence, when the installation of a small turbine is planned, it is well to provide an atmospheric relief valve of a size equal to the area of the throttle valve times the ratio the boiler pressure carries to the pressure at which the atmospheric valve is set, and no stop valve should be placed between that relief valve and the turbine. This arrangement would require a separate relief valve for each turbine.

An effort has been made in some cases to correct existing installations by installing some kind of an interlocking device intended to prevent the opening of the throttle valve until after the valve in the exhaust line has been opened. Such a device might be considered as entirely dependable if it were designed also to prevent the closing of the stop valve in the exhaust pipe until after the throttle valve had been closed.

A recent explosion of a turbine at the plant of the American Seeding Co. at Grand Rapids, Mich., has been attributed to the presence of a stop valve in the exhaust pipe between the turbine and the atmospheric valve and to the fact that the interlocking device intended to correct the error did not prevent closing the exhaust valve when the throttle valve was open, as the result of which the turbine casing was exposed to more pressure than it could withstand. The facts are that this particular unit lost its load and one of the watch engineers, thinking he had the throttle, closed the exhaust valve instead. The results are shown in the reproduced photograph. Fortunately, no one was injured, but the low-pressure end of the turbine was wrecked and some damage was done to the generator driven by the turbine.

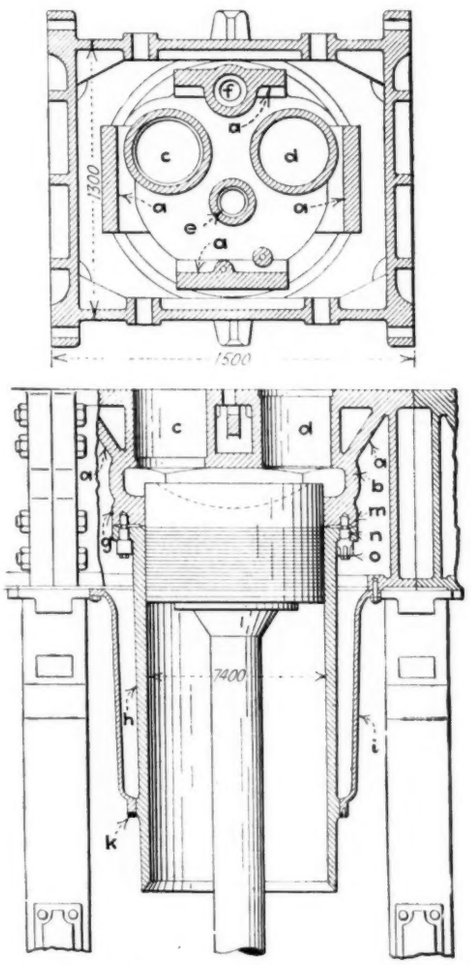
New Diesel Cylinder Design*

Ample longitudinal rigidity is essential to multi-cylinder Diesel engines to take up the external stresses safely. This calls for skilled structural design, with the masses properly distributed to preserve rigidity. The latest cylinder design adopted by the A.E.G. Burmeister and Wain engines in which these principles are observed, is shown in the illustration.

In contrast to the earlier types, in which the cylinder jacket walls surrounding the liners were designed as upper horizontal supports and in which individual round heads were fitted to each cylinder, the new design has square cylinder heads that are rigidly bolted together to form the upper horizontal support of the engine, whereas the baseplate constitutes the lower horizontal support.

As can be noted from the cross-section, the square cylinder heads are in fact inverted open boxes, with smooth side walls, reinforced by stiffening ribs. The upper round section *b* of the working cylinder is suspended at four points by the sloping ribs *a*. The head has openings *c* and *d* to receive the air inlet and the exhaust valves, and openings *e* and *f* for the fuel and starting valves, respectively. The cylinder liner *h* is bolted to the flange *g*, only part of the liner being surrounded by cooling water. The jacket wall is a separate casting, which is also suspended from the head. It is made watertight at its lower end by rubber packing *k* in a stuffing box.

The cooling water enters at the lower portion of the



A. E. G. Diesel cylinder construction

jacket and then passes through the latter into the hollow spaces in the cylinder head. No gasket is used in the joint *m* between the cylinder head and liner, as this would make it difficult to maintain a true vertical alignment. Instead, the joint is formed by the contact of the ground surfaces of two narrow rings on each flange.

To prevent corrosion, the end of the bolts *n* and their nuts, which are continuously surrounded by the jacket water, are fitted with bronze caps *o*, sealed watertight with rubber.

IN AN ARTICLE ENTITLED "A Study of Combustion Events Taking Place in an Oil Engine," abstracted from *Zeitschrift des Vereines deutscher Ingenieure* and published in the Jan. 26 issue of *Power*, mention was made of the Fullagar and Doxford two-stroke-cycle Diesels. The author, Doctor Mader, calls attention to the fact that the research work discussed was carried out at the Junkers-Werke at Dessau, Germany.

*Reported by V.D.I. July 24.

Spread Between Most Economical and Maximum Ratings of Steam Turbines

DURING the last year there seems to have been in this country a tendency to demand a wider margin between the most economical load of a turbine-generator and the maximum load that it will carry. In many installations this is probably due to the fact that the load factor on the unit is relatively poor. By lowering the most economical point of operation, the average performance of the plant will be improved.

The growth in the size of units is another reason for increasing the overload capacity of the turbine. If the largest unit on the system were to drop its load suddenly, the other units must be operating with a sufficient margin to pick this up, in order that continuity of service may be maintained. With the present rapid growth in the size of units, it is not uncommon to find a system with one or two units so large that it becomes a real problem to provide the necessary reserve capacity when they are in operation.

If conditions warrant lowering the output at which the highest efficiency occurs, it is justified by the reduced cost of the installation. A turbine may be built to carry loads far above the conventional ratings of today without much additional expense, if the spread between the load for best efficiency and the maximum load is increased. The generator cost, however, depends upon its maximum continuous rating.

All of this emphasizes anew the importance of the study, from all points of view, of the relation between the characteristics of the individual machine, of the system it is to belong to, and of the load to be carried.

Arithmetic and Engineering

LIFE would be pleasant if engineering were built on the plan of arithmetic! For a given problem there can be but one right answer, and that can be calculated to as high a degree of accuracy as may be desired. No exercise of judgment is called for. One has simply to learn the rules and apply them uniformly in all cases. A careful man need never make a mistake. Moreover, he can always prove that he is right. There can be no difference of opinion.

Years ago, Professor Sweet used to tell his students a story to show the difference between the mathematician and the engineer. Pointing out a near-by steel bridge, he described how loads and stresses and sizes are calculated, and how when each step is finished, the result is multiplied by something—the factor of safety. "Now," said Professor Sweet, "the mathematician can do the figuring; the engineer is the man who tells him what to multiply by."

It is easy to study a power-plant problem from the viewpoint of fuel economy and to set up comparisons of plan against plan. But when all this is done, it is still necessary to choose, and the choice may involve many things having nothing to do with heat, and perhaps some things that cannot even be expressed in numbers.

There is no royal road to good engineering. Hard study of all the factors, followed by careful weighing of merits, and concluded by an exercise of sound judgment, is the only way.

Problems are not clearly stated. Data are uncertain. Future trends must be estimated. The best man may be wrong in his final decision, but an occasional error is not a serious reflection on his ability. The real mark of a man of high ability is that he does not overlook any significant part of his problem. His choice of evidence in both nature and amount is the test of his skill.

Observations at Basel

THE sectional meeting of the World Power Conference at Basel had a twofold object: First, to favor interchanges of opinion and information between technical experts of different countries, with the idea of pooling the resources of the World in knowledge and practical experience, in the production and utilization of power; secondly, to establish contacts and foster friendly relations among prominent and influential individuals of different nationalities, with a view to establishing channels for future interchanges of information and mutual service.

There is no question that the second purpose was fully attained. Those who attended the Conference and felt the simple, genial friendliness that pervaded its sessions, will have brought home a lasting regard for the foreign engineers whose science and personality have contributed much toward the establishment of international friendships and understanding.

As to the first objective, however, there may well be raised doubts as to its having been attained. The task was too great and the time much too short. One cannot take up eight or ten reports in a two-hour session, and expect much in the way of tangible discussion. It would have been much easier for the delegates had they been able to read and digest the various papers at home or in the office instead of in a dimly lighted hotel bedroom, particularly under the disturbing consciousness that fifteen or twenty papers must be covered before morning, if one were to "keep up" with the sessions. No really fertile discussion could result under such conditions.

What was needed to make the Conference truly productive was discussion. For this purpose time would have been required in which to study each report, to form opinions, have them translated and listen to someone's answer; and above all, time to concentrate on a single report, not ten at once.

In this respect some of the sessions were much better than others. In those devoted to the electrification of railways the discussion was interesting. All speeches were given, at least in abstract form, in German, English

and French. These sessions really got down to business. By far the most hopeless sessions were those devoted to inland navigation and water power. In these attempt was made to cover thirty-four reports in six hours.

These observations should not be taken as a criticism of the management of the Conference, because it was of the highest quality. It is surprising that much good material could be brought out under such trying circumstances. But the task was too great. The program was too comprehensive for the time allotted. Metaphorically, one cannot dam up the mental energy of the technical élite of the world for two or more years and suddenly throw the sluice gates wide open with the expectation of controlling the flood and utilizing the energy.

More Than One Interest To Be Considered

OUR rivers have been classified as the greatest undeveloped natural resource. It might well be added that they have been the most misrepresented. Advocates of water-power development, particularly the political ones, have been inclined to paint a picture of waterfalls being capable of solving all our difficulties, irrespective of where they may be located or the influences of other economic factors. This has also been more or less true of those interested in navigation, irrigation, fish, municipal water supply and sanitation. Each has endeavored to show that his was the most worthy cause.

It is evident that all the claims made for our waterways cannot be correct, at least in every case. Many of the word pictures of these resources have been painted in ignorance of the facts or for the purpose of influencing public opinion, without regard to the validity of the case.

Probably no two waterways are utilized under like conditions. In a district where fuel costs are high, other economic factors being favorable, development of rivers for power purposes might well take first place. Where a district is rich in fuel and is developed industrially so that there are large quantities of bulk freight to be transported, navigation may become of paramount importance in waterway development. An agricultural district in an arid section of the country may rightly have a first claim on the water.

A good example of the influence of local conditions on the use to which rivers may be put, is found in the Provinces of Ontario and Quebec, Canada, and in the State of Pennsylvania. The former have no coal and are so situated that in whatever way fuel is obtained the cost is high. These two provinces have large potential water powers, which, along with other natural resources, have made possible great industrial developments. In this case the question of navigation on their rivers, except the St. Lawrence and the Great Lakes, has been to a large extent subordinated to that of power development. Turning to the State of Pennsylvania, fuel is near at hand and cheap. In many cases the industries are close to the mines and power can be produced from fuel at a low cost. Therefore, in such districts it is natural that water resources should have a higher economic value for navigation or for industrial purposes than for water-power development. Influence of location is also shown in the utilization of rivers in the Pacific Coast States. There the joint interest of power development is frequently involved with irrigation, fisheries and municipal water supply, and these take precedence over navigation. The nature of many of the rivers of that region precludes them from any consideration for navigation, but for other purposes they possess large possibilities.

Before we can expect an intelligent policy regarding our water resources, it will be necessary to have some national body or bodies such as recently recommended by Secretary Hoover, that will consider these problems from the broad viewpoint of the economic factors affecting them so that they may be developed in a way to produce the greatest benefit.

Instruments Have Won Acceptance

EXCEPT for a few steam gages and manometers the average power plant of twenty years ago was practically devoid of instruments. Today designers and wide-awake operators look upon indicating and recording instruments as necessities for economical operation.

It is true that a trip around the country will reveal many plants that are still operated "blindfolded." Few are being built that way, but there are many old plants limping along with obsolete equipment—generally dark holes full of junk, oil and water, with steam leaking and covering hanging in shreds from the steam pipes. These are the hoboes of the power-plant world. They take about the same interest in instruments that a tramp without a decent suit of clothes does in an accurate timepiece. In all fairness there must also be added a smaller group of plants where the absence or scarcity of needed instruments is not a measure of the engineering ability of the engineer, but merely a reflection on the short-sighted policy of the type of management that cannot be induced to spend a little to save a lot.

Wherever good engineering advice is sought and followed today, instruments are installed to measure the primary quantities of plant operation and generally some of the secondary quantities as well. The measurement of feed water (or steam output), coal consumed and draft is taken for granted. And it is only in the most temporary installations that engineers of standing will willingly omit instruments to measure flue temperature, water temperature, steam pressure and superheat. Many more are often included.

There is some difference of opinion as to how many instruments are worth while under a given set of conditions. Some confine themselves to so-called essentials, while others believe in substituting facts for guesswork in as many details as possible. But there is general agreement that a substantial investment in instruments is well worth while.

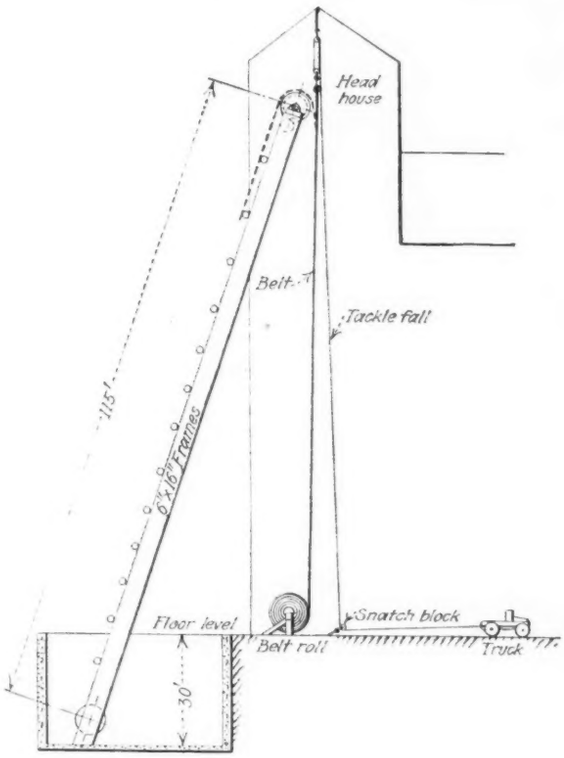
This acceptance has been won by backing up promises with performance. Not all instruments come up to the mark, particularly in careless hands, but the net gain, after allowing for individual disappointments, has been so great as to convince the most conservative that the average instrument installed pays its keep several times over.

For many years high steam pressures remained in the realm of discussion. Their successful employment, once demonstrated, has been followed not only by wide application, but by large incremental pressure increases. Nowhere is this more noticeable than in the large modern industrial power plants, many of which are now putting equipment into operation at pressures which, only a few years ago, would have balked the most progressive central station.

Practical Ideas From Practical Men

Installing a Continuous Bucket Elevator

The plan we used in erecting a continuous bucket elevator, containing approximately 170 30x10x15-in. buckets might be helpful to other engineers. The buckets were mounted on a 10-ply 32-in. wide, ¼-in. rubber covered belt, 115 ft. center to center. The elevator frame was of 6x16-in. timbers built in sections on the ground and raised in place. The elevator rested at a



Tackle used in putting belt on elevator

slope of 5 in. in 12 ft., the lower end being in a pit 30 ft. below ground level and fed from a track hopper.

To install the belt, the roll of new belting was mounted on a shaft sitting in temporary bearings, on the ground level, and underneath the head pulley. A wooden clamp was attached to one end, with a hook for lifting gear. A block and tackle was hung from the top of the building over the head pulley, and the fall end led through a snatch block on the ground, and attached to a truck. With all the rollers on the elevator and the head and tail pulleys in place, one end of the tackle was attached to the clamp, and the roll of belting unrolled by running the truck ahead, and so raising the end of the belt until it was above the head pulley. Here it was made fast a short distance from the end, and the end itself was draped over the pulley with the clamp still in place. Then a rope was attached to it and led to the truck, which was run ahead until enough belt had been run out to reach to the bottom of the pit, or to counterbalance that on the other side of the pulley. The belt was drawn as tight as possible, to allow for stretch and a temporary splice or connection made. Owing to the stretch, which could not be foretold, the correct length could be arrived at only after all the buckets were on, so that in case it was necessary to cut out a few feet of belt the permanent splice would not be affected.

For setting the buckets, a templet sufficient to take care of five buckets was made, and the holes, twenty to a bucket, were drilled through it. One gang went ahead with the templet drilling the holes and were followed up by two men placing the buckets and tightening the bolts. When the end was reached—that is, when the last bucket was on—a gap of only 3 in. was left, which was cut out and a final connection of the belt was made by using plate fasteners. A reinforcing strip of ⅜-in. belt 15 in. long was put on the back of the connection, and attached with the bucket bolts, except the leading edge, which was riveted on to prevent it from curling on the pulleys.

M. C. COCKSHOTT.

Hollywood, Calif.

Is Fuel Economy the Most Important Thing?

While not denying that efforts to keep the coal bill down to the lowest figure should be given credit, reliability should not be sacrificed to economy. This applies alike to stationary plants and sea-going vessels, and I have seen coal-saving ideas adopted which for the long run turned out to be losses instead of profits.

A marine chief engineer in charge of a 1,700-hp. triple-expansion engine reduced the coal consumption of his vessel by piping the auxiliary exhaust into the low-pressure receiver but wrecked his engine. The receiver pressure was 5 lb. and went up considerably when the auxiliary exhaust was added, thus raising the power in the low-pressure cylinder. The cutoff in the high-pressure cylinder was then shortened to keep the speed of the engine the same. About a ton of coal a day was saved and the thing looked all right at the time.

Making port early one morning on the second assistant's watch, steam was turned into the deck line for warming up the winches. Shortly after a slug of water entered the receiver and knocked off the low-pressure cylinder head. The engineer closed the throttle at once before the accumulation of steam in the engine room became serious. The water of course came from the winches. The drips had been piped into the exhaust pipe in order to save fresh water when using the winches in foreign ports. The winches were cold at the start, and the amount of condensation coming through the exhaust line into the receiver was sufficient to flood the receiver. Only the high-pressure cylinder was provided with relief valves, although each receiver had relief valves. The low-pressure valve had a balance piston on top of the steam chest which prevented it from lift-

ing far enough off the seat to relieve the pressure. The valve also was found broken.

Not desiring to call for a tug, the chief and his crew set about getting the engine in shape to come in under her own steam. The broken valve was repaired by steel straps and the chief decided to make an emergency cylinder head, as we were entering a port where no repair shop was nearer than 150 miles. Two thicknesses of floor plates were taken and holes drilled corresponding with the cylinder studs. It was then decided to use only half as many bolt holes as in the original head, as drilling out the broken studs was a long job, only one ratchet drill being aboard. The remaining studs were cut off flush with the face, alternate studs being drilled and chipped out. While this work was in progress, the piston rod and connecting rod were examined. The piston was blocked at top stroke and the crankpin bearing dismantled. The crank was placed on the top center and the distance from the inner surface of webs to the foot of the rod was calipered and found to be equal fore and aft. The vessel was placed on an even keel by pumping ballast and the center of the rod at the foot came directly over the center of the pin, which satisfied us that the alignment was fairly accurate. No springing being evident, the piston follower was removed and the rings found to be all right. The improvised head was put in place and a ½-in liner placed under the foot of the connecting rod to reduce the clearance at the top, which was more than double the original clearance. A delay of 18 hours was occasioned by the accident. The plan of proceeding to sea with only two cylinders was thought of and discarded as taking unnecessary risk, since it was the hurricane season. After a few hours in port taking cargo, we started our three-day trip to Galveston, being ordered to that port by the owners for repairs. We made our usual speed without further trouble, and on the home trip the exhaust from the deck engines was piped to the condenser. Had this safety precaution been observed when the auxiliary exhaust was first turned into the receiver, the engine would not have been wrecked.

C. G. H. HART.

Thompsonville, Conn.

Guarding Steam-Driven Air Compressors Against Overspeed

A recent minor accident at our works causes me to believe that a steam-driven air compressor should have a speed-limit governor, or in other words, two governors. Most air compressors, unless of the Corliss-valve type, are equipped with what is known as an "unloader" type of governor, which controls the steam to the engine in accordance with the demand for air.

Now this form of governor simply regulates the speed to keep up the air pressure in the receiver if for any reason the air pressure suddenly falls away, the steam valve is opened practically full, regardless of the safe speed limits of the engine.

The case in mind occurred recently, when a workman, having a hose a trifle short, connected to a manifold, could not hold his air drill in perfect position and gave an extra hard pull on the hose, with the result the nipple broke between the manifold and the union on the supply pipe.

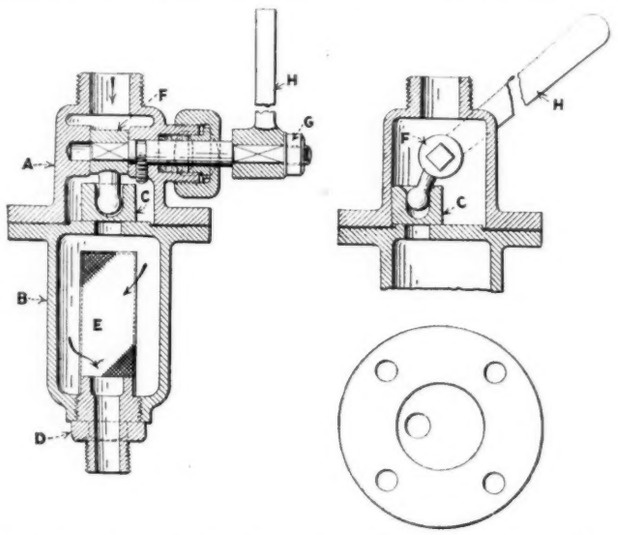
The air compressor increased in speed at once as the pressure lowered on the receiver, and the unloader, instead of limiting the speed, was opening the steam valve wide and the compressor was actually running away when the engineer came in the room and closed the throttle valve. When the speed was once more at normal, there was no pressure in the receiver, so the pipe fitters were sent out in search of the trouble and found the broken nipple in the line leading from the receiver to the manifold. It is seldom that an engineer is so handy to close the throttle valve in such emergencies, and it appears to me that, as the "unloader" type of governor checks the speed of the compressor only when the pressure limit is reached, another governor should always be used to prevent the compressor from running away when the air pressure drops to a minimum and the throttle valve is wide open.

Cambridge, Mass. R. A. CULTRA.

Compressed-Air Valve and Strainer

One of the troubles in a compressed-air plant is to obtain a suitable stop valve and coupling between the main line and the flexible pipe of the various tools in use about the plant.

Not being able to obtain anything that we thought suitable for continuous operating without the necessity



Valve and strainer for compressed-air line connections

of being constantly on the lookout for leaks, we made one of the type shown in the illustration and have had over thirty in use for over two years without giving the slightest trouble.

At the left is shown the valve and strainer complete. The two main parts *A* and *B* are made of gun metal. *A* being attached to the main pipe in the position shown, at any desired point. As will be seen, the seat for the valve is on the body *B*, which is also tapped to take the nipple *D*, upon which is soldered a fine gauze strainer as shown. The outer end of the nipple is threaded to take a standard hose coupling. With this arrangement the strainer can be removed at any time for cleaning purposes. The valve *C* is made of phosphor bronze and is operated by the lever *F*. through spindle *G* and handle *H*. With a properly ground seat and valve (which is free to turn and thus insure even wear) the pressure makes a tight seat. Should regrinding be necessary, the uncoupling of *B* exposes both seat and valve. Suitable marks on the flanges of *A* and *B* for location purposes are also an advantage.

Belfast, Ireland. F. P. TERRY.

Comments from Readers

What Causes Bubbles in Ammonia Receivers?

I have been much interested in the discussion in the columns of *Power* regarding the problem of bubbles in ammonia gage glasses, since the same difficulty was encountered in our laboratory refrigerating plant.

The plant in question being solely for experimental use, it is important to have means for measuring the weight of ammonia in circulation. Therefore two vertical cylindrical receivers are installed in parallel between the condenser and the expansion valve. Gage glasses run the full length of the tanks, with graduated scales behind them for reading the level of the liquid ammonia.

The first time the plant was operated, bubbles rose continuously through the glasses, making accurate reading of the level impossible. After everyone present had made a few haphazard guesses as to the cause of the bubbles, we realized that the ammonia coming from the condenser was several degrees cooler than that which had stood over night in the receivers. This lowered the pressure on the surface below the value corresponding to the temperature of the body of liquid in the tank, whereupon this liquid naturally began to boil, sending bubbles of vaporized ammonia to the surface.

The obvious cure was to reduce the quantity of condensing water until the ammonia leaving the condenser was slightly warmer than that in the tanks. As soon as this was done the bubbling stopped.

In my opinion there is no possibility that such bubbles are air. If air is present in the system, it will surely not collect below a body of liquid in a tank.

Rochester, N. Y. J. W. GAVETT, JR.,
Professor of Mechanical Eng'g.,
University of Rochester.

Embrittlement Theories

In the Sept. 7 issue of *Power* Sheppard T. Powell gives a summary of the various theories regarding caustic embrittlement that should prove very enlightening to those to whom caustic embrittlement has hitherto been a bugaboo rather than a definite problem confronting the operators of high-pressure steam generators. Practical men who, by choice or circumstance, are using highly alkaline water from the steam-generation point of view, are not so much interested in theories of caustic embrittlement as they are in its abatement. To them the findings of Mr. Powell, Doctor Parr and others, which recommend the maintenance of a certain sulphate to hydrate ratio in the boiler, are of paramount interest.

In the plant in which the writer is employed, the method of feed-water treatment necessitates the carrying of caustic and carbonate concentrations in excess of those ordinarily found in stationary boilers, the total alkalinity often running as high as 1,000 parts per million. The boilers are of a water-leg water-tube type, and the presence of stalactites at both ends amply attests the fact that there is good opportunity for seepage. The stalactites are chiefly sodium sulphate, with a little free alkali present. The sulphate ratio has been maintained at its recommended value, and no trace of caustic embrittlement has been found in three years of such treatment, even though the boilers are operated almost continuously at more than 250 per cent of rating.

To the writer's mind the chemical theory of caustic embrittlement receives a striking confirmation in the fact that caustic embrittlement (as far as the writer is aware) always occurs below the water line. It should be apparent that far greater concentrations, up to unity, may be reached in the seams of the steam space owing to the re-evaporation of entrained moisture on the steam space metal which is swept by the flue gas. Here, however, in contradistinction to the water space, we have all seepage incrustations in a rather dry form and therefore in an inert form so far as chemical reaction at temperatures usually existing is concerned.

The nascent hydrogen theory of embrittlement seems to have several inconsistencies that demand explanation. In the water space hydrogen may be evolved in two ways—by electrolytic action and by the action of hot caustic solution on iron. The latter reaction is held to be the controlling one in the boiler seams. So-called nascent hydrogen is produced by both reactions, and its absorption by the metal is subject to the same final state of equilibrium, namely, that in which the iron, under the same conditions of temperature and pressure, has absorbed the same amount of hydrogen regardless of the process or reaction that has produced it. This conclusion has been experimentally verified, as the results of T. S. Fuller, reported in Mr. Powell's article, show. It immediately follows that neutral or acid waters should show hydrogen embrittlement, as in these waters the electrolytic evolution of hydrogen is much greater than it is in alkaline waters.

In the steam space and superheater there is a third hydrogen reaction that may take place. This is the reduction of steam by hot metal to give hydrogen and iron oxide. While this reaction is not carried out under favorable temperature conditions in a boiler, it goes on to some extent and the hydrogen produced thereby is every bit as "nascent" as that produced in the water space. It would seem that the mere consideration of hydrogen would lead to the conclusion that the metal is uniformly embrittled. This is not so. The advocates of the theory bring in localized strain areas and then appear to explain things satisfactorily.

The apparent immunity of the steam space cannot be satisfactorily explained, as shown herein, by the hydrogen theory. It is, however, perfectly consistent with the supposition that concentrated caustic solutions attack the amorphous cement at the crystal boundaries, as suggested by Professor Parr. This jibes with the localized strain theory and seems to explain all observed facts in a satisfactory manner.

New York City. ALFRED A. MARKSON.

Increase the Demand

I happened to be in the works manager's office of a large industrial concern when a business-like gentleman entered and without preliminaries stated with abrupt conciseness:

"We can't get diemakers any more for ninety cents an hour."

The works manager drummed on the table with his fingers and looked out of the window.

"What can you get them for, George?"

"A dollar, dollar five, maybe ten."

"Try a dollar."

The business-like gentleman, who was the employment manager, then went out.

Throughout that big plant many bright young men make time studies of every operation and figure the cost to the fourth decimal of a cent. But here is a factor that increased the cost 10 per cent or more, which was decided without a pencil. When George could not get diemakers for 90c. an hour, he had to raise his bid to get them. It can be readily inferred that the rule works the other way equally well. If George could get diemakers for 25c. an hour, he would pay just that. In fact, the records show that he has paid just that in the past.

What other basis is there for wages and salaries? Admitting the high cost in time and money of engineering education, the knowledge and experience, what reliable thing can bring salaries higher and maintain them above the level of demand and supply?

The technical schools train thousands of young men every year to design steam turbines, gas engines, generators and motors, notwithstanding the fact that the number of men actually engaged in each of these activities in the United States is small.

The supply is great, and it seems that something should be done toward restricting that supply by raising the quality. However, it may also be possible to do something toward increasing the demand. The raisin growers of California have increased the demand for their product many times over that of a few years ago. Cannot something be done in that direction for engineering services?

I once did some work for a large concern whose piping had been laid out and installed by a "practical" steamfitter foreman. He obtained his pipe sizes solely by inspiration and intuition. The steam mains, two 22-in., were three times too large. The heating return line, 14 in., was about six times as large as necessary. The weirdest loops and bends were placed here and there, yet lots of trouble was had from the pipe "pulling in two." The interest and other fixed charges that could have been saved on that piping job would have paid the salary of a good engineer.

Investigation of the proposed installation of a mixed-pressure turbine for another large concern revealed that practically all the steam lines supplying steam for heating and processes which required only low pressure, were so small that boiler pressure was required to supply the services. Salesmen of power-plant products can tell of opportunities in practically every plant they visit for the installation of more modern equipment that would pay large returns on the investment. Allowing generously for the selling pressure, there is little doubt that this condition is fairly general.

The problem, then, seems to be to get across to plant executives in general the fact that sound engineering talent is a good investment. It would seem that through the technical papers the matter could be presented in a convincing and persistent way. Important, too, is the constant hammering home of the fact that every member of the profession should do at every occasion.

West Toledo, Ohio. J. R. BELKNAP.

Economies of Multi-Stage Steam Ejectors

A recent article in *Power*[1] brought up and discussed a really important phase of air-ejector application, namely, the economies of multi-staging in the steam-jet air ejector. There is little doubt that the thermal requirements of air removal apparatus are reduced to a minimum, by the use of an ejector of an infinite number of stages, and that for practical purposes the two- or three-stage ejector is about the limit that can be used.

However, there may still be room for development in the two-stage ejector field, before the intricacies and refinements of the third stage can be justified.

In this article mention was made of the fact that a 30,000-kw. unit may be served by a two-stage (presumably) ejector, which, with a steam consumption of 600 lb. per hour, or $\frac{1}{4}$ per cent of the total main unit requirements, and while handling 5.6 cu.ft. of free air per minute, will maintain a pressure of 1-in. absolute in the condenser.

The writer does not feel that such figures as this indicate the need of further staging of ejectors to make gains in steam consumption. On the contrary, the company with which he is associated has developed the two-stage ejector to the point where its product will and is performing this same duty in a number of installations with a steam consumption of under 200 lb. per hour, or $\frac{1}{12}$ per cent of the total. This performance is with steam at 125 lb. available for operation. With steam at 300 lb. available, a further reduction of 10 per cent in the steam requirements may be obtained.

In view of the 33 per cent reduction at 1-in. absolute obtained, in the article, by going to a third stage, it would appear that a well-engineered two-stage ejector can still hold its own with a high-stage ejector type, while requiring less intricate operating layouts and methods, when this range of pressure is required. However, when pressures around 0.5 in. and less are desired, then the three-stage ejector comes into its true field. For use in connection with turbine units, however, the writer doubts if pressures above 0.5 in. are much in demand, owing to the limiting vacuum characteristics of the present-day turbines. In the industrial field there is no such limitation, and there has been developed and applied successfully a line of three-stage ejectors for extremely low absolute pressures. Ejectors of this line have been designed and are in operation, which will give pressures at shutoff at less than 0.05 in. of mercury.

The writer is very glad to find that his statements, in an article on air ejectors published in *Power*, March 16, 1926, concerning the advantage of a throttling orifice for pressure reduction over the usual reducing valve, have been confirmed in this article, and feels, too, that the field of higher pressures should extend to the air ejectors. However, care must be used that the ejectors are designed for the minimum steam pressure encountered in the plant, and this often limits the ejector

[1] "Three-Stage Air Ejector Uses Less Steam," by D. W. R. Morgan, July 27, 1926.

pressure to a low value. The ejectors must be made reliable under the worst operating conditions. Where there are operators to attend to the bypassing of the orifice at such times, the orifice plate would seem entirely reliable. Where the plant is under-manned, the reducing valve is still desired, and by proper engineering can be made entirely reliable. C. E. COLBORN.

Jeannette, Pa.

Finding a New Engineer for the Power Plant

A difficult problem often presents itself when the power plant must put on a new chief engineer. It is many times a question which is the wisest course to pursue to secure the right sort of individual, one with whom the plant staff can co-operate properly and who at the same time has the right ability. Sometimes an outside man is procured after considerable trouble and the results later prove disappointing.

Sometimes this sort of engineer is an experienced man, but that applies particularly to the plant from which he came. Often he is wholly at sea in the new surroundings. Likely he cannot be dismissed summarily, having been granted a suitable contract to assume charge. He comes, too, with rather set ideas; he has his pet theories and notions, and many times he will not tolerate others' opinions. Therefore, he cannot secure co-operation from those working with him. Many power plants have found out as much to their regret and loss.

The old-timer, on the other hand, represents a valuable asset to that power plant in which he has been employed over a long term of years. He understands, as no other engineer can, that particular plant's problems. Take him out, however, place him elsewhere, and, notwithstanding a lengthy engineering experience, he will be wholly at sea in the new plant. He will meet perplexing problems because he is an utter stranger, notwithstanding the fact he has had wide experience and is well recommended.

Others in the power plant may resent the intrusion of an outsider, with whom they probably cannot work in entire sympathy. Sometimes, too, it is felt that the position should have been given to one of the force; thus we have dissatisfaction and dissension. Some loyal plant man probably had been priming himself for an engineering job, and naturally he feels neglected when a newcomer is installed over his head. A sequence to this disappointment is that he seeks a position elsewhere, more in conformity with his desires. It would be a wise procedure to canvass among the force regarding abilities and ambitions, keeping them in mind when new appointments are in order.

Some executives prefer to engage a man of so-called varied experience, acquired from a number of plants. This sort of individual usually is not so prejudiced against others' ideas and he is more receptive to suggestions and will welcome rather than reject others' opinions. That is an important point to bear in mind. Also, he knows better how given situations are met and solved in different plants. The more opportunities an engineer has had to witness how various power-plant problems are solved, the better fitted is he to undertake responsibility. Furthermore, he appreciates better a new, strange-to-him, plant's needs. He is thus more open to the help of others.

After all, why turn to outsiders for possible engineer material? Outside sources should not be considered until inside possibilities have been exhausted. Many times, good material in the plant is overlooked in the often hasty desire to procure an outside man.

When it is known that worthy individuals inside the power plant are offered promotions, there is implanted a desire for growth. The man with engineering ambitions will set forth for the time when he is deserving and when the opportunity presents itself. The power-plant executives can accomplish much here by inspiring capable material to do still better through periodical meetings where various engineering problems can be discussed. Regular interchange of ideas will do much to reveal true engineering possibilities inside the plant.

The way another's ideas are looked forward to, what suggestions are offered to overcome vexing problems, discloses the nature of engineering ability of a given individual. Worth-while textbooks can be provided, encouraging the men to read and to study, and thus to prepare themselves for the higher step. Different kinds of educational means will suggest themselves, and these can be discussed among the plant force. The more a man studies the more he naturally will know, and so far as the power plant is concerned, the instruction can be guided so that it will prove of outstanding value to both plant and individual.

Consider the individual advantages offered by choosing a man from the staff. Not unlikely he has been employed by the plant for a number of years. In that time he has watched and considered this plant's varied engineering problems. He knows, from experience and service given in this one plant, its outstanding, best needs. He knows the men working in the plant with him; he knows their peculiar failings, temperament, characteristics and individual abilities. Can you say the same of your well-recommended outsider, however experienced he is in one plant?

He is familiar with the power plant's machinery, its different equipment. He knows what materials have been used, where purchased and why. When he assumes charge he knows, indeed, many things wholly foreign to the experienced outside engineer. Many of these things on the surface may appear insignificant, but on the whole they decide materially whether the new engineer is to fail or succeed.

Many times the appointment of an outside engineer is governed by hearsay; much has been said of what the individual accomplished in a given plant. Of his real abilities, as desirable for your own power plant, little is known. You have an entirely different situation when considering a man from the ranks. You have at your finger-tips certain information that was acquired from observation and experience with this man. Naturally, he steps up as a likely candidate for engineer. Why do so much expensive experimenting with outsiders when there is good material right within the power plant? The insider has not earned his niche in the new position of engineer, so he strives all the harder to deserve it. The outsider, to the contrary, often feels he is securely placed, since he has presumably earned it on past results in the one plant from which he is being lured away. He is not lightly going to quit a good steady position to take on uncertainty. However, as has many times been proved, past results do not weigh materially when new conditions, new situations, new problems have to be met.

Brooklyn, N. Y. FRANK V. FAULHABER.

A new slant on things observed in and out of the power plant

What Happens and Why?

Plotting Growth Statistics

HOW fast is your business (or output) growing, or how rapidly are your expenses increasing? These are questions that concern many today. One of the easiest ways to study these

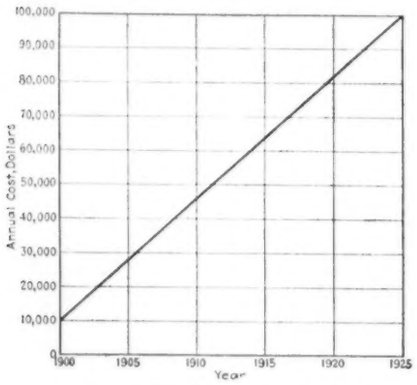


Fig. 1—This is not a healthy development

conditions is with the aid of a special form of chart that anyone can plot and intelligently analyze.

Limitations of Usual Form of Chart

Before considering this special form of chart, the limitations of the usual type of chart may be illustrated by an example from the commercial world. As will be shown later, similar principles hold in plotting engineering statistics. Consider the diagram in Fig. 1 representing the growth of a business concern from 1900 to 1925. At first glance one would say that this represented a healthy development. This business has increased $3,600 each year for twenty-five years.

However, one begins to have doubts as to the handling of this business when Table I is consulted. From 1900 to 1905 the increase in business was 1.8 times the business in 1900. In the next five-year period, this ratio had dropped to 0.64, and for succeeding periods dropped successively to 0.39, 0.28 and 0.22. Possibly, the pioneers

TABLE I—BUSINESS GROWING WITH EQUAL INCREASES EVERY FIVE YEARS

Period	Five-Year Increase	Annual Sales — Start of Period	Annual Sales — End of Period	Ratio of Five-Year Increase to Business at Beginning of Period
1900–1905	$18,000	$10,000	$28,000	1.8
1905–1910	18,000	28,000	46,000	0.64
1910–1915	18,000	46,000	64,000	0.39
1915–1920	18,000	64,000	82,000	0.28
1920–1925	18,000	82,000	100,000	0.22

TABLE II—BUSINESS GROWING AT AN EQUAL RATE EVERY FIVE YEARS

Period	Five-Year Increase	Annual Sales — Start of Period	Annual Sales — End of Period	Ratio of Five-Year Increase to Business at Beginning of Period
1900–1905	$6,000	$10,000	$16,000	0.6
1905–1910	9,600	16,000	25,600	0.6
1910–1915	15,360	25,600	40,960	0.6
1915–1920	24,576	40,960	65,536	0.6
1920–1925	39,322	65,536	104,858	0.6

in the business were better "go-getters" than the present officers. Unless this condition can be satisfactorily explained, the growth is not healthy and Fig. 1 might prove misleading.

Suppose this business, amounting to $10,000 in 1900, had had an increase every five years amounting to 0.6 the business at the start of the period. The amount of this growth is shown in Table II and also in Fig. 2. Is it not a more logical standard for a good business to grow at a steady *rate* as indicated here rather than by steady *increases?* And yet, since the desirable condition is a curve in Fig. 2, it is difficult to see at a glance if the curve is of true shape or too straight. If it

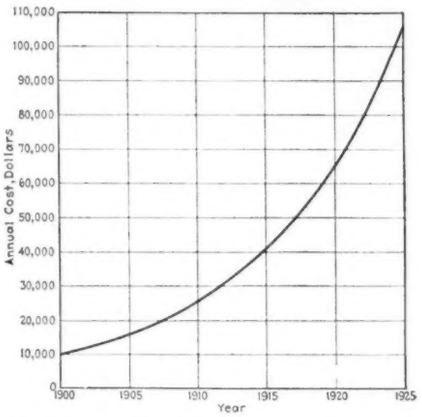


Fig. 2—This is a healthy development

were too straight, it might approach the condition of steady numerical increase rather than steady rate of increase and yet be undetected.

A More Useful Type of Chart

If these same data are plotted on a chart having logarithmic subdivisions in one direction and uniform subdivisions the other way, the result is interesting. Before considering the result, however, let us consider briefly the type of paper on which these charts can be constructed.

It is called semilogarithmic paper, but in spite of the name no knowledge

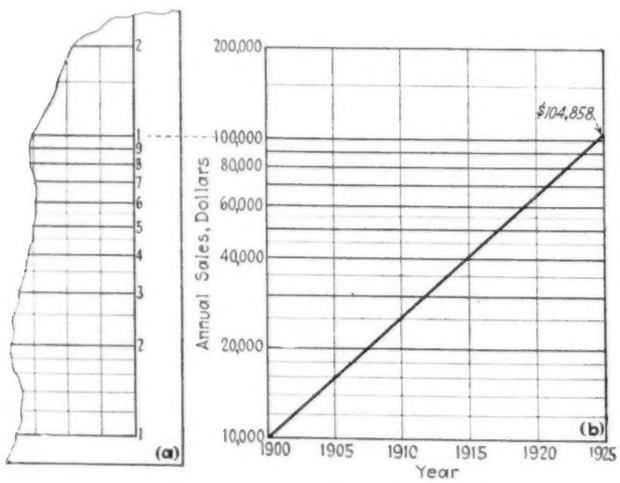


Fig. 3—Showing, without distortion, constant ratio of increase in business

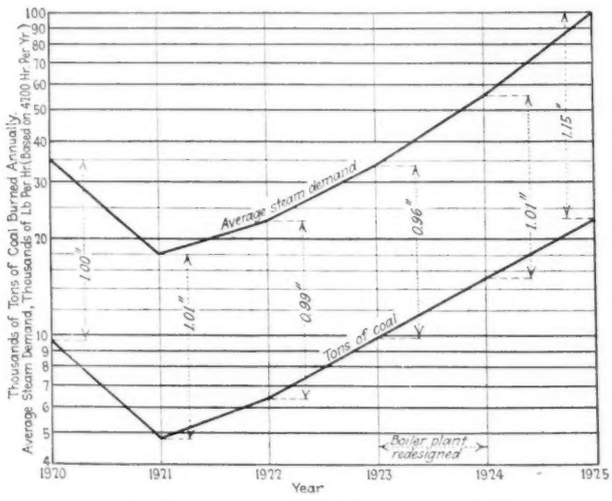


Fig. 4—Showing relative changes in steam demand and coal consumption

of logarithms whatever is necessary in using it. It is available from manufacturers of cross-section paper, and once the user is assured it is scaled logarithmically in one direction, his connection with logarithms ceases.

Fig. 3 (*a*) shows the corner of a sheet of this type of paper. The digits 1, 2, 3, etc., appear at intervals, because the vertical scale, unlike the usual scales, must be laid off according to a definite rule and not entirely at the option of the user, as is the case with ordinary paper. At each point labeled "1" must be located 0.01, or 0.1, or 1, or 10, or 100, etc., the next higher point labeled "1" being taken ten times as large. Fig. 3 (*b*) shows how this scale is fixed to cover the range of Table II.

The curve of Fig. 3 (*b*) is plotted from the data of Table II. When the business is in a satisfactory condition, or growing at a steady rate, its plot is a straight line on this paper. If the curve falls off from the straight line, even though it continues to rise, it means an increase but at a decreasing rate. Possibly the manager, warned by such a curve, could take steps to correct troubles in his business. The slant of the line plotted is a measure of the ratio or rate of the increase. The steeper the line the faster is the growth.

Applications in the Power Plant

The ingenious engineer can undoubtedly think of many uses for this form of chart. However, unless "growth" is involved in the problem, the chart is of no importance. It so happens that many engineering problems involve growth.

Fig. 4 illustrates a possible use. In this chart is pictured the average steam output and the tons of coal burned per year in a steam boiler plant. It is seen that from 1921 to 1925 there was practically a steady rate of increase in the demand for steam. There was also, of course, an increased coal consumption. One interested in the details of the performance would wish to know whether the coal consumption relative to the steam output was increasing or decreasing.

Bettered performance means that the curves spread apart farther and farther. The performance in 1921 is seen to be better than in 1920, because the coal consumption dropped farther than the steam demand. However, after 1921, the performance was progressively worse until 1924. A note on the chart indicates that the boiler plant was redesigned in 1923-24, and the benefit appears in the bettered performance in the last two years plotted.

A criticism of this chart could be made on the basis that the same facts could be brought out by plotting the ratio of the tons of coal per year divided by the average steam demand in pounds per hour against the year on the usual type of cross-section paper. However, such a chart has the disadvantage of not giving the absolute values for any year, of the coal consumption and the steam demand. These data can be read directly from Fig. 4.

Steaming Tests with Indiana Coal*

BULLETIN No. 26 of the Engineering Experiment Station of Purdue University presents the results of 212 steaming tests made with representative Indiana coals. These tests were conducted on a great variety of hand-fired and stoker-fired boiler plants, by members of the university staff and others.

Since most of the tests were secured under ordinary operating conditions, some of the results obtained were not so good as they might have been. The poor, as well as the good results, are reported.

The tests reveal over-all boiler efficiencies as high as 69 per cent with fire-tube boilers and 78 per cent with water-tube boilers. Boiler capacities of 125 or 130 per cent of rating were secured with hand-fired grates, and capacities as high as 275 or 280 per cent were obtained with stoker-fired boilers.

Setting design and care in operation seems to be the two major factors that influence ratings and efficiencies. With proper furnace design a reasonable amount of care on the part of the plant operators will insure satisfactory results with Indiana coal with any type of boiler or combustion equipment.

No attempt has been made to consider the item of boiler maintenance in conjunction with the use of Indiana coal, this item being important more particularly when excessive boiler capacities are attempted.

All the Indiana steam coals have a volatile content between 35 and 40 per cent, and it is for this reason that the question of furnace volumes is important. The moisture content as received at the plant may be from 7 to 14 per cent and the ash from 8 to 18 per cent. The heating value is usually between 11,000 and 12,200 B.t.u. per lb. as received. The sulphur content ranges from 1 to 4 per cent.

Indiana coal, almost without exception, exhibits no caking tendencies when fired on any type of grate, so that there is no trouble from that source in handling it.

The No. 5 seam coal from the Clinton district seems to produce an ash and refuse that make it difficult to burn on underfeed stokers. One test, on an underfeed stoker, could not be completed. The ash and refuse made by this coal consisted of large chunks of clinker that had apparently been in a very plastic state inside of the furnace, as they contained pieces of unburned coke embedded all through them. This same coal had been used with entire satisfaction on a chain-grate stoker in the same plant.

Ignition difficulties were encountered with some of the coals. This trouble is particularly noticeable on a chain-grate stoker. Ordinarily, it is encountered only when an attempt is made to operate at high ratings or when there is a sudden increase in the boiler load.

Most Indiana coal is well suited for use on chain-grate stokers, and good efficiencies can be secured with either natural or mechanical draft. Only one Indiana coal was found that could not easily be burned on an underfeed stoker. This same coal was handled very well at higher rates of combustion on mechanical-draft, chain-grate stokers.

On some of the tests reported, rates of combustion of 50 pounds of dry coal per square foot of grate surface per hour were secured with mechanical-draft, chain-grate stokers. With underfeed stokers combustion rates as high as 38 lb. of dry coal per square foot of grate surface per hour were secured in ordinary plant operation, and under test conditions a combustion rate of 39.4 lb. of dry coal was secured. With natural-draft, chain-grate stokers combustion rates of 40 lb. of dry coal per square foot of grate surface per hour were attained under test conditions.

*Abstracted from Bulletin No. 26 recently published by the Engineering Experiment Station of Purdue University, A. A. Potter, Dean of the Schools of Engineering, Director.

Lack of Efficiency in Engineering Schools

The following suggestions from a recent paper by the well-known civil engineer, J. A. L. Waddell, are interesting even though they are likely to stir up opposition.

In most technical schools there is a vacation of three months in the summer, another of ten days about Christmas time, and another of a week in the spring. Now why should engineering students work less time per annum than do practicing engineers? Some may claim that, on account of being younger, students need more leisure and rest; but the speaker is inclined to deny the validity of this plea, because the majority of them attain most of their growth and vigor before undertaking the engineering course.

Granting that the student, on account of his youth and because of his being unaccustomed to strenuous mental activity, is entitled to twice as much leisure as the practicing engineer, he could be given a vacation of a month at midsummer and a week at Christmas.

Abuse of the lecture system used to be one of the fundamental causes of lack of efficiency in engineering schools, and to a certain extent it is yet. There is a legitimate place for the lecture in a technical curriculum, but it is a quite limited one. The speaker has previously indicated to what extent lectures to engineering students are permissible.

The principal objections to them are as follows:

A. The lecturer does the hard thinking instead of the student.

B. Lectures are quickly forgotten unless notes be taken during the discourse.

C. It is not feasible, simultaneously to take notes and listen attentively to all the lecturer is saying.

D. Numerous mistakes are made in taking lecture notes; and when the records are studied or referred to later, these mistakes are both misleading and exasperating.

E. Any lecture that is worthy of being taken down as notes by the hearers is certainly worthy of being printed in pamphlet or book form by its author.

F. Lecturers and lecture notes are extravagant of the students' time and are, therefore, objectionable on the basis of true economy.

Recent Publications

A Treatise on Hydraulics. By Hector J. Hughes, Dean of the Engineering School, Harvard University, and Arthur T. Safford, Consulting Engineer. Published by The Macmillan Company, New York City, 1926. Cloth; 6x9 in.; 362 pages, 122 illustrations; 39 tables. Price, $4.

This book represents a happy combination, namely, the thinking of a university professor and a practicing engineer, both of long experience. In this second edition the attempt has been made to cut down the size of the volume and yet retain most of the material of the first edition and add new material to bring the book up to date. It has long been recognized that the solution of hydraulic problems must, in a large part, be based on experimental data. It is around this idea that the text has been prepared. In general, when formula and conclusions are given, they are accompanied by a brief description of the experiments upon which these are based.

In the open chapter a brief résumé is given of the work of those who have contributed to evolving the basic theorems and formulas of hydraulics for the last two thousand years. Following this are chapters on fluid pressure; fluid pressures of varying intensity; the equilibrium of floating solids; fundamental principles of hydromechanics; the flow of water; the pitot tube, piezometers, the pitometer; the venturi meter; orifices; special forms of orifices; nozzles and fire hose; weirs; float and current-meter measurements; flow of water in pipes and conduits; the flow of water in open channels; dynamic action of flowing water; and waterwheels and pumps.

The treatment has been arranged with the object in mind of making the book a text on practical hydraulics and also useful to the practicing hydraulic engineer in solving every-day problems. Many problems are worked out to show how the theoretical and experimental data are applied to practical hydraulics. A large amount of the experimental work is given that has been carried out in the more simple phases of hydraulics. No attempt has been made to cover the more complicated problems, but, as the authors pointed out in the preface, generally, these can be resolved into components which can be solved by the various methods given in this book.

A valuable part of the book is the tables, which include coefficients and discharge rates of nozzles, data on the characteristics of weirs and current meters, flow of water in open channels, tables of roots, powers and conversions used in hydraulic calculations. A chart is also included for computing the flow of water in open channels by the Chezy and the Kutter formulas. Although the book has been written primarily for engineering students and practicing engineers, it contains much that can be easily understood by those who have not had the advantage of a theoretical engineering training.

Mathematics for Engineers.—By Raymond W. Dull, consulting engineer and research engineer of the Link-Belt Co. Published by the McGraw-Hill Book Co., Inc., New York City, 1926. Cloth; 5½x8 in., 780 pages, illustrated. Price, $5.

In fifty-seven chapters the author covers the subject of mathematics from the viewpoint of the engineer, beginning with arithmetic and ending with integral calculus. The volume is a valuable collection of material over the entire range of mathematical analysis. While it is written for the engineer, the work is not a treatise on applied mathematics, but a somewhat heterogeneous compendium of topics in mathematical theory which the author believes will be useful to the engineer. On this there is room for difference of opinion. The reviewer feels certain that some of the topics included would rarely interest the practicing engineer.

In handling each topic, the author has made the initial treatment elementary, assuming little previous knowledge on the part of the reader, and for this reason the work is far more than a condensed handbook for reference, but the presence of this explanatory material may perhaps somewhat impair the value of the work for the busy engineer who desires to refer quickly to formulas and methods without taking time to read lengthy discussions.

On the other hand, the absence of practice problems and the somewhat confusing collection of so many topics in one volume, together with the brief treatment accorded some of them, does not recommend the volume as a textbook for beginners.

The value of this book will be for the man who stands between the two extremes, neither an uninformed beginner nor an expert. For the busy engineer who finds it necessary to brush up on some particular mathematical problem and whose memory of the relevant material is none too good, the book should prove of considerable value.

It is unfortunate that in a work covering the field so thoroughly there should be defects impairing its value. For example, in explaining the usefui check by "casting out nines," the author misses a detail that great facilitates the application of the method.

Perhaps the most misleading error is found on page 276, where, in spite of a long chapter on absolute and relative errors, the reader is told that the slide rule will yield the product of 527.85 × 3.14 = 1,657.67 by the astonishing expedient of multiplying 3.14 by 527 and by 0.85 separately and adding the results! Just how the number 1,655, the first of these products, is secured accurate to one-hundredth of a unit, to justify the addition of the second product, 2.67, is not clearly explained. Similarly, we are told that 45,681 × 38,266 may be found by the slide rule to be 1,748,167,350! We expect absurdities of this sort from schoolboys, but it is somewhat surprising to find them in a book written by a practicing engineer.

A.S.M.E. Boiler Construction Code, Suggested Rules for the Care of Power Boilers, Section VII—the report of the subcommittee of the Boiler Code Committee on Care of Steam Boilers and Other Pressure Vessels in Service. Published by the American Society of Mechanical Engineers, 29 West 39th St., New York City, 1926. Stiff paper; 5½x7½ in.; 88 pages. Price $1.25 to members; $1.35 to non-members.

These rules are compiled to assist operators of steam boiler plants in maintaining their plants in as safe condition as possible, the subject of economy receiving only incidental consideration. The code includes rules for routine operation; operating and maintaining boiler appliances; inspection; prevention of direct causes of boiler failures, and partial rules for installation. The appendix contains approved methods of investigating and reporting analysis and the treatment and control of feed water with the intent of standardizing methods and forms. This is not intended so much for the operating engineer as for those specializing in the chemistry of feed water. The Code thus submitted was approved by the Boiler Code Committee and upon its recommendation by the Council of the Society at its meeting of Jan. 13, 1926.

Elementary Steam Engineering. By E. V. Lallier. D. Van Nostrand Company, 8 Warren St., New York City, 1926. Size, 5½x8 in.; 288 pages; 116 illustrations. Price, $2.50.

The purpose of this book is evidently to provide a description and some idea as to the design of equipment that is found in a small power plant. The author, who is an instructor in the Hebrew Technical Institute in New York, is talking to the stationary engineers in such plants or to men interested in these engineers' work.

Unfortunately, many of the illustrations and principles are out of date. For example, a hand-fired water-tube boiler is shown in Fig. 6 with the fire right up against the boiler tubes. One is surprised to find that the chapter entitled "Rotary Engines" deals with the turbine, and that "the Curtis steam turbine is interesting due to the fact of its being a vertical turbine." These are not the only examples that could be quoted, and they lead one to the conclusion that none of the newer developments now common in the small plant is adequately treated.

On the other hand, for the reader who wishes to know something about boiler auxiliaries and attachments, the mechanism and mechanical details of the steam engine, the indicator, piping and fittings, lubrication, packing and insulation, etc., a study of such portions of this book will be justified.

Illinois Petroleum, Press Bulletin Series No. 4 has been issued by the State Geological Survey at Urbana, Illinois.

This bulletin presents discussions on the possibility of further oil production in two areas from which oil is now being extracted. The first article suggests areas near the Martinsville pool, Clark County, which are worthy of test drilling. The second article is a preliminary report on oil investigations in the Centralia area.

News in the Field of Power

Water Power Commission Sets St. Lawrence Terms

Bringing to a climax a controversy that has been the football of politics in New York State for upward of 15 years as to whether private interests or the state should develop state owned power, the New York State Water Power Commission adopted on Sept. 24 a resolution prepared and introduced by Attorney General Albert Ottinger, setting forth the terms and conditions under which a license for the development of St. Lawrance River power will be issued.

Friday Oct. 15 was decided on as the date upon which the final hearing will be held, after publication of notice, prior to the issuance of a license for development.

It was also determined that the two applicants for a lease, the American Superpower Corp. and the Frontier Corp., or one of them, must have filed an acceptance of the terms, set forth in the resolution adopted by the Commission, before Sept. 30 in order that the final hearing may take place on Oct. 15 as scheduled. It will be recalled that the Frontier Corp. bids with a single-stage development and dam at Barnhart Island, and the American Superpower Corp. with four different plans, but also favoring a single-stage development.

The commission's resolution is a formal adoption in legal terms of the conditions which, on June 29, the state engineer recommended being included in any license. Briefly stated, they are as follows: The license shall be for 50 years from its date. The licensee must secure approval of other governmental and international bodies of its plan and start construction within three years and must be able to produce at least 500,000 hp. within the next five years, and the total output of 1,200,000 hp., (one-half of the total at the site) as soon thereafter as practicable. A $10,000,000 faithful performance bond must be furnished before starting construction. The licensee must report every expenditure and the commission has power to allow only those items which it approves to be placed on the company's books. The state shall have power to regulate rates and capitalization. The licensee must protect navigation and provide locks for existing navigation routes as well as make provision for lock and other facilities for a future ship canal if required. Navigation is to have first call upon the water of the river and municipalities first call on the power.

At the expiration of the license period all property, in a perfect operating condision, vests absolutely in the state of New York. The state, under certain conditions, may purchase the entire plant at cost, less the amount then in the amortization reserve, plus 15 per cent.

For the privileges granted, the state shall receive (1) an administration charge of $75,000 per year, (2) a cash license charge of $2.25 per horsepower of plant output per year, and (3) annual payment to amortization reserve which shall be sufficient to retire the cost of the property at termination of the license.

The commission stipulates in its terms that the dams and power houses must be so constructed that there will be on the New York side of the international boundary line a power house capable of controlling the flow of the river and producing at least half of the power which may be generated from the entire development.

Hoover Advocates National Water Development Plan

The United States must consider the development of its water resources as a whole and should proceed at once with a great national plan of construction, advised Herbert Hoover, Secretary of Commerce, speaking before leaders of the Missouri River project at conferences held at Omaha, Neb., on Sept. 29. Reiterating his views on this question, he said in part:

"We have reached a new era in development where we can form National policies for full use on our streams and lakes. Water is our greatest undeveloped resource, and now that we have the capital we should go ahead with that development.

Must Look Ahead

"We must take a large vision, must consider each drainage system separately, organize the first step at once, proceed with the engineering projects which are certain, and prepare to enter a national construction program. I believe we would be negligent if we do not undertake this great development."

Such an organized program could develop 35,000,000 hp. from water instead of the present 11,000,000; bring 25,000 miles of modernized waterways on streams and lakes and add 30,000,000 acres of land to the country's agricultural domain by reclamation, Hoover predicted.

"Our water resources lie all over the nation. By creating a national sentiment for such development the West will receive due consideration for its problem. The questions of navigation, power and reclamation simplify themselves as part of a whole program.

Great System Economical

"Unfortunately, the whole of disadvantages arising are reflected into the Mid-Western territory. With higher labor and material we cannot contemplate much reduction in rail rates, as railroads are the most efficient in history. We must seek an alternative.

"Within the Mississippi system are 9,000 miles of possible waterways. A great system will be more economical than a single river development.

"Criticism of this program comes from two sources, agriculture and railways. The agricultural community feels it is over-producing foodstuffs and believes it is unwise to bring other lands into production. But in ten or fifteen years we will need it."

Electrical Manufacturers Form National Body

Announcement was made Sept. 25 of the creation of the National Electrical Manufacturers' Association, an organization consisting of 270 leading electrical manufacturers with a gross annual business exceeding $1,500,000,000. The new organization, with Gerard Swope, president of the General Electric Co., as president, was formed by the merger of the Electric Power Club, the Associated Manufacturers of Electrical Supplies and the Electrical Manufacturers' Council. J. W. Perry, vice-president of the Johns-Manville Co., Inc., was made treasurer.

The general purpose of the new association is to advance the art of manufacturing adequate and reliable electrical equipment and to standardize electrical apparatus, which, it was said, will ultimately mean lower costs and lower selling prices to the public. The association will co-operate with the Department of Commerce in its constructive work.

Specifically, the objects of the new association, according to its constitution, are to further the interests of the makers of electric apparatus and supplies in manufacturing, engineering, safety, transportation and other industrial problems; to promote the standardization of electrical aparatus and supplies; to collect and disseminate information of value to its members or to its public; to appear for its members before legislative committees, governmental bureaus and other bodies in regard to matters affecting the industry; to promote a spirit of co-operation among its members for the improved production, proper use and increased distribution of electrical apparatus and supplies.

The charter members include Allis-Chalmers Manufacturing Co., Anaconda Copper Co., Crocker-Wheeler Co., Crouse-Hinds Co., Cutler-Hammer Manufacturing Co., Electric Storage Battery Co., General Electric Co., Landers, Frary & Clark, National Carbon Co., Inc., National Metal Molding Co., Reliance Electric & Engineering Co., Robbins & Myers Co., Western Electric Co. and Westinghouse Electric & Manufacturing Co.

Mechanical Engineers Hold Meeting at Richmond

Power and Textile Sessions Have Chief Interest—Many Historic Sites Visited—Varied Program Offsets Small Attendance

ALTHOUGH somewhat smaller in attendance than had been anticipated, the Regional Meeting of the A.S.M.E. in Richmond, Virginia, last week proved an occasion that will long be remembered by those privileged to attend. With the technical sessions held to a minimum, time was available for visits to the many historic points in and about Richmond, and the local committee lived up fully to the traditions of the Southern Host.

Monday was taken up by an all-day meeting of the Council, followed by a reception in the evening. On Wednesday morning there were held two sessions, one devoted to the Wood Industries and the other to the Textile Industries. At the latter the present difficulties of the industry were analyzed and conditions in New England and the South compared.

On Tuesday evening a symposium was held under the direction of the Management Division, at which various phases of mechanical engineering were discussed in their relation to the management of industry. After introductory remarks by President Abbott and Chairman R. P. Kent, Dr. F. R. Low spoke briefly on steam power, Prof. R. W. Angus on hydro-electric power, Roy B. Wright on transportation, H. B. Coes on budgeting, Floyd M. Chapman on standardization, E. R. Fish on research, and Prof. E. O. Eastwood on finance.

At the power session on Wednesday morning three papers were presented. The first, by Arthur Scrivenor, of Richmond, reviewed conditions as found in many industrial power plants and showed how the consulting engineer can be of service by checking up existing conditions and offering suggestions toward better results. In such cases it is most necessary that he have the active support of the management and the co-operation of the operating force. The speaker made a plea for keeping of more intelligent operating records.

A paper on "The Design of High-Pressure Industrial Power Plants," by R. S. Baynton, described the new plant of the Chesapeake Corporation at West Point, Va., where high-pressure boilers operating at 425 lb. supply a 1,500-kw. turbine exhausting at 130 lb. to a medium-pressure header. This header supplies steam for certain processes and also for two medium-pressure bleeder turbines of 750 kw. each, which furnish lower pressure steam for other processes and run part condensing in accordance with the steam and electrical demands. With this arrangement an almost perfect heat balance is obtainable and the estimated savings over the old low-pressure plant amount to $136,500 per year. These savings will pay for the investment in less than three years. Air preheaters and three-effect evaporators are some of the refinements in the new plant. A description of the plant and its operating conditions will appear in an early issue of *Power*.

Superpower and Interconnection

W. C. Bell, chief engineer of the Virginia Electric & Power Co., outlined some of the power interconnections in Virginia and North Carolina. The speaker differentiated between "superpower" and "interconnection," pointing out that the former applies to those electrical supply systems serving a relatively large area through transmission lines from large high-economy power stations, whereas the latter means the physical interconnection by transmission lines of existing systems for mutual protection and the exchange of electrical energy. He reviewed the general agreements under which such interconnection exists and outlined the companies and existing connecting lines in Virginia and North Carolina.

The three papers evoked considerable discussion, during which the exchange of power between industrial plants and utilities was reviewed from both angles, the utility men present being generally opposed to the idea on the ground that such privately generated power often could not be taken by the central station at advantageous times, and there was some fear expressed that it might affect the system power factor.

Other points brought out in the discussion included reference to the absence of deleterious effects on refractories and stokers through employment of preheated air, and the placing of the steam accumulator in plants having rapidly fluctuating and heavy process steam demands.

Following the Richmond meeting the members left for visits to Williamsburg, the capital of Colonial Virginia, and historic Jamestown, and then embarked on boat to Washington, stopping off at Newport News to visit the big shipbuilding plant of the Newport News Shipbuilding & Dry Dock Co., at Norfolk, for visits to Langley Field and Fort Monroe and at Yorktown.

At a luncheon at Norfolk on Thursday, Prof. H. L. Seward read a paper on "Fuel Conservation in the U. S. Government Merchant-Marine Fleet." In this he discussed the functioning of the Fuel Conservation Section of the Shipping Board.

The marine engineer, said Professor Seward, is given a certain combination of equipment, located in constricted spaces, and supplied with a certain kind of fuel, and with this he is expected to furnish propulsion, heat, refrigeration, light, fresh water and many other services in a sure and steady manner. His staff is subjected to a tremendously high turnover, and he naturally has to train it to operate and attend the machinery before he can develop the best in economy and begin to conserve fuel.

Inspection of Active Vessels

With the standards of performance at sea determined, it was necessary to organize a systematic inspection of the active vessels of the fleet. The inspector must be able to size up the conditions on board the vessel, give the log careful scrutiny, and be able to analyze this record of performance promptly during the next stay of the vessel in port. From the continuous record of the vessel's performance it should be determined whether or not an improvement in operation is being made, and what effects any modifications made in the equipment of the vessels or in

Group Attending the Regional Meeting of the A.S.M.E. at Richmond, Va.

methods of operation have on the ship's performance. The operators receive prompt notice of the performance on each voyage of each of their vessels and are held responsible to the government for economy of operation.

The first page of the voyage report is headed with a brief description of the physical characteristics of the vessel, which serves to classify the type of the particular vessel covered by the report. Following this is an analysis of indicator cards, which is filled out if the vessel is propelled by steam-driven reciprocating engines. A brief report of the physical condition of the various departments and equipment of the vessel is given, together with a rating based on an A, B, C, D schedule. The engineer officer personnel is also rated under three headings—mechanical ability, discipline, and efficiency—these ratings to represent the degree of each of the foregoing characteristics shown on this particular voyage. The engine-department crew, its equipment and the operation of the vessel are rated on the same schedule.

On the report is also the fuel summary, which gives a continuous record of the bunkering and consumption of the vessel and checks the fuel consumption, which is shown under headings of "Sea Consumption," "Port Consumption," and "Consumption in Pilot Waters."

The Fuel-Oil School

Through this system of inspection close touch is kept with the operating vessels of the fleet, and it becomes a comparatively simple matter to determine the relative performance of any particular vessel at any time and to direct the efforts for improvement toward the poorer performers so as to bring them up to the standard of their sister ships. It is apparent also that by means of these inspection reports it becomes comparatively easy to determine from an operating point of view the relative standard of operating efficiency of the managing operators.

The co-operation on the ship combined with competition among ships is one of the valuable results of fuel-conservation work. In order to get the best results from this competition a fuel-oil school was established in October, 1922, through the courtesy of the United States Navy, at the Philadelphia Navy Yard Fuel Oil Testing Plant, where a short, intensive course of instruction is given in the principles and practice of combustion and the methods of attacking the problem of boiler efficiency in a logical and intelligent manner so as to obtain maximum results.

Rochester Gas & Electric To Build New Heating Plant

Plans are now being made by the Rochester Gas & Electric Corp. to construct a new central heating plant at Lincoln Park, N. Y. The immediate purpose of this plant is to supply steam for the works of the General Railway Signal Co. in accordance with the terms of a contract recently signed.

Steam will be supplied at 5 lb. for heating, and at a pressure of 50-100 lb. for process work. A non-condensing turbine will furnish heating steam. While the details have not as yet been worked out, it is probable that the initial boiler installation will comprise two or three high-pressure units of fair size.

S. Firestone, consulting engineer, of Rochester, is preparing the planning for the Rochester Gas & Electric Corp. with the co-operation of R. D. De Wolf, mechanical engineer.

John Quincy Adams
President of the N.A.S.E.

Refrigerating Men Plan Big Convention and Exhibits

The National Association of Practical Refrigerating Engineers will hold its seventeenth annual convention and educational exhibition in Kansas City, Mo., Nov. 2-5.

Arrangements for this gathering have been planned on a much greater scale than in previous years and the meetings will be held in Kansas City's municipal convention hall, which has been the scene of some of the largest conventions ever held in the United States. Excellent opportunity for the display of heavy machinery such as is used in the ice and refrigerating industry will be afforded. The exhibition will occupy approximately 16,000 sq.ft. of floor space, and according to C. L. Whittemore, of St. Louis, chairman of the association's national exhibits committee, all available space has already been allotted. The convention headquarters will be at the Hotel Muehlebach.

The convention program has been arranged by the association's educational and examining board, and men of national prominence in the refrigeration engineering profession will present papers on a wide range of subjects, covering ice making, cold storage, packing house, ice cream, dairy, and the like. As in the past, a valuable feature of the N.A.P.R.E. programs is the discussion which follows the master papers, participated in by the best informed engineers among the thousand or more expected for attendance.

Kansas City has an abundance of fine hotels, and the local hotel committee, under the chairmanship of M. W. Stout, 504 Dwight Building, has reserved 2,000 rooms for the convention at moderate prices. Those who intend to go should write Mr. Stout for hotel reservations.

Engineers Visit New Plant of Bethlehem Steel Corp.

Six hundred and fifty members of the Association of Iron and Steel Electrical Engineers visited the new power house and rolling mills of the Bethlehem Steel Corp., at Johnstown, Pa., on Saturday Sept. 25.

The morning was devoted to inspecting the new substation and mill. The main roll drives in this mill are all direct-current motors, supplied from a substation containing five 2,000-kw. motor-generator sets. Each set consists of a 6,600-volt synchronous motor driving two 250-volt 1,000-kw. direct-current generators. The direct-current busbars extend for a distance of 580 ft. under the mill in a four-foot concrete tunnel. The busbar system of this station contains 226,923 lb. of copper.

At noon the visitors were the guests of the company at luncheon and in the afternoon were taken on an inspection trip of the rest of the works and to the new power house. In the boiler plant for the new power station a 50-50 mixture of blast-furnace coke screenings and bituminous coal is burned on underfeed stokers. The power house contains one 15,000-kw. unit and operates in parallel with two other plants on the system, making a total installed capacity of 47,500 kilowatts.

New Power Plant Described

In the evening dinner was served to the party and at a technical meeting, R. H. Stevens, chief engineer and F. W. Cramer, assistant electrical superintendent, Johnstown Works, Bethlehem Steel Corp., presented papers describing the new power plant and works. An article describing the power plant installation is being prepared for publication in *Power*.

At this meeting the names of the new officers of the Association of Iron & Steel Electrical Engineers were announced. These are: President, S. S. Wales, chief electrical engineer, Carnegie Steel Co., Pittsburgh, Pa.; first vice-president, A. J. Standing, electrical superintendent, Bethlehem Steel Corp., Bethlehem, Pa.; second vice-president, C. S. Proudfoot, general manager, United States Ferro Alloys Corp., Buffalo, New York; treasurer, James Farrington, electrical superintendent, Wheeling Steel Corp., Steubenville, Ohio; secretary, F. W. Cramer, assistant electrical superintendent, Bethlehem Steel Corp., Johnstown, Pa. The directors elected are: C. L. Baker, management representative, Bethlehem Steel Corp., Johnstown, Pa.; H. C. Seibert, combustion engineer, Bethlehem Steel Corp., Bethlehem, Pa.; A. G. Place, electrical engineer, Youngstown Sheet & Tube Co., Youngstown, Ohio; R. S. Shoemaker, superintendent of maintenance, American Rolling Mills Co., Middletown, Ohio; and F. L. Collins, electrical superintendent, Illinois Steel Co., Chicago, Ill.

Tennessee Eastern Electric Argues for Large Project

Petition of the Tennessee Eastern Electric Co., of Johnson City, for permission to begin and carry forward hydro-electric power developments in upper east Tennessee, involving estimated expenditures of $4,500,000, was presented and argued before Major C. Fiske, divisional engineer of the Federal Power Commission, at a hearing held recently.

The application specifies the selection of five locations as dam sites on the Holston and Watauga Rivers, in Hawkins, Sullivan and Washington Counties; and refers to five additional sites contemplated on the Nolichuky River in Greene County, above the present power dam near Greenville. These later five, however, were not discussed at the hearing.

The formal petition shows the location of one proposed power dam near Galbraith Springs; one near Hemlock, four miles east of Kingsport; one near the junction of the Watauga and the Holston; one near Bluff City on the Holston, and one near Watauga on the Watauga, the five to develop a total of about 240,000 hp.

The petition was supported by oral statements of officials of the company. D. R. Shearer, general manager, detailed needs for additional power at this time, in this section, and the advantage of having facilities at hand for supplying contemplated industries.

To Install Largest Single-Cylinder Turbine

The largest single-cylinder, single-flow steam turbine-generator rated at 63,000 kw., is being built by the General Electric Co. for the Edison Electric Illuminating Co. of Boston. It is to be installed in the Edgar station at Weymouth.

This turbine will operate at 350 lb. and 725 deg., with exhaust pressure at one inch absolute, and will drive a 60,000-kw. main generator and a 3,000-kw. auxiliary service generator. Generation will be at 14,000 volts and 60 cycles. Equipment now in service in the Edgar station includes two 32,000-kw. and one 3,000-kw. units, the last operating at 1,200 lb. pressure.

The largest single-cylinder turbines in use today are rated at 50,000 kw. (1,800 r.p.m.), and 60,000 kw. (1,500 r.p.m.). This turbine, with a capacity of 63,000 kw. at 1,800 r.p.m. thus will establish a record for capacity at any speed for single-cylinder machines.

Northern Michigan Power Concerns in Merger

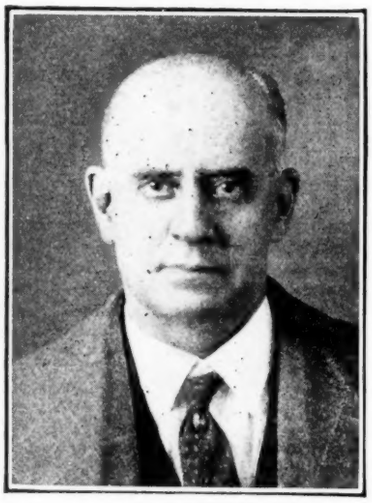
Consolidation of six small northern Michigan utility companies with the Michigan United Light & Power Co., was authorized Sept. 23 by the state public utilities commission.

The companies to be taken into the organization are the White River Power & Light Co. The Boyne City Electric Co., the Boyne River Power Co., the Michigan Public Service Co., the Elk Electric Co. and the Grayling Electric Co.

William P. F. Hill, Operating Engineer, Dies

William Pitt Fessenden Hill, for nearly forty years an operating engineer of wide experience, died Sept. 26 at Syracuse, N. Y. Entering the field in his twentieth year, he followed the calling to the day of his death, at that time in charge of the Hotel Syracuse, as chief engineer and superintendent of building maintenance.

He first served three years as watch engineer for the Bridgeport Electric &



William Pitt F. Hill

Power Co., from 1887 to 1890. He soon came to New York, however, and served the New York Edison Co. as engineer at the old Duane Street Station. During the years 1893-1904 he served as assistant and chief engineer for the Grand Union Hotel Co., Genessee Fruit Co., the Woman's Hospital, New York, John J. Crook Tinfoil Co., and the Western Electric Co. He was also foreman for the New York Central Railroad. He was long a member of Phœnix Association, N.A.S.E., New York City. At the time of his death he was an active member of Technology Club, Syracuse and I.U.S.E., No. 11, of that city.

Mine Wage Conference May Convene This Month

A wage conference before the end of this month rather than in February, as provided by the Jacksonville agreement, would be in the public interest as well as in the interest of the operators and the mine workers, is an opinion apparently generally held in administration quarters.

Among the proponents of coal legislation at the last session of Congress emphasis was placed on the probability of an effort to break the union at the expiration of the Jacksonville agreement. This expression of opinion seems to have impressed industry. Fearing that such an effort may be made and that a long drawn-out fight would result, the large consumers of coal are expected to begin building up their stocks long in advance.

Ottawa Fears Policy Selling Power to United States

Apprehension is manifest in Ottawa regarding the course the new Mackenzie King Government will take on the question of the export of electric power to the United States.

It is recalled that when in office Mr. King and his colleagues were very noncommittal as to their attitude whenever the matter was raised in Parliament by members of the Conservative Opposition. It was only after a strenuous fight in the House of Commons by the Conservatives that the government, the session before last, was compelled to accept a resolution in some measure restricting the issue of export permits.

The present concern arises out of influences attending the formation of the new ministry. Friends of the Liberal party who are not being ignored in the present Cabinet-making are interested in the proposed Carillon development on the Ottawa River. Application was made to the government by the Carillon interests two sessions ago for permission to export power, although after the storm raised by the Conservatives, no action was taken.

Monument to Westinghouse Will Be Erected

A committee chosen from among executives of the Westinghouse corporations has been named to represent the enterprises founded by George Westinghouse in the work of erecting a memorial to him in Schenley Park, Pittsburgh, Pa., to perpetuate esteem for his life and work.

Designs and a location have already been chosen for the monument. A shaded hillside near Panther Hollow in the park is to be the site for the memorial, which will bear witness to the achievements of the man regarded as one of the most unique personalities and typical figures in the industrial growth of his times.

Carolina Light & Power Co. Project Likely

In a report to the Federal Power Commission the Chief of Engineers recommends the issuance of a license to the Carolina Light & Power Co. covering its project on the Big Pigeon River in Haywood County, North Carolina. This company formerly was the Pigeon River Power Co. It proposes to build a dam 150 ft. high and to install equipment sufficient to generate 60,000 hp. The primary capacity of the project is 13,500 hp.

Inasmuch as this project is not involved in any of the controversies over the general development of the Tennessee River, it is presumed that the Commission will act favorably on this application for license.

Obituary

John Overn, manager of the Dominion Engineering Works, Ltd., of Montreal, Canada, died at Ocean City, N. J., on July 2, 1926, it has just been officially

announced. He was educated in the public schools of Philadelphia and served his apprenticeship at the Baldwin Locomotive Co. Later, he was in charge of the pattern shop of the Barr Pump Engine Co. From 1898 to 1923 he was employed in the I. P. Morris Department of William Cramp & Sons, in charge of the department that produced hydraulic machinery. He was born in Philadelphia in October, 1868, and became a member of the A.S.M.E. in 1914. Mr. Overn was a Mason and a member of many organizations, including the Union League Club of Philadelphia.

Personal Mention

Francis B. Longrey, formerly with the Dow Pump & Diesel Engine Co., is now consulting engineer, 3623 Grand Ave., Oakland, Calif.

Martin J. Conway has resigned his position as fuel engineer for the Wheeling Steel Corp. to take a similar position with the Lukens Steel Co. at Coatsville, Pa.

George E. Learnard, president of the International Combustion Engineering Corp., and Walter Barnum, president of the National Coal Association, have accepted invitations from President Thomas S. Baker to serve on the advisory board for the International Conference on Bituminous Coal at Carnegie Institute of Technology, Nov. 15-19.

Business Notes

The Dominion Engineering Works, Ltd., Montreal, has appointed Hubert Gray Welsford as general manager. Mr. Welsford was associated with the late John Overn, Jr., who was in charge in that capacity until his recent death.

George F. Murphy, who has been sales engineer for the Heine Boiler Co. for the last twelve years, has resigned to take up his duties as president and general manager of the Mogul Machine Co., with main office in the Witherspoon Building, Philadelphia, Pa.

The Link Belt Co. of Chicago has opened a new branch office in Utica, N. Y., at 107 Foster Building, 131 Genesee St. This branch will be devoted especially to the sale of the Link-Belt silent chain and roller chain. F. P. Hermann, Jr., will be in charge.

The Graybar Electric Co. has announced several changes in management and personnel of the company's distributing houses in Southern territory, effective Sept. 27. George T. Marchmont, at present manager of the Richmond branch, has been appointed Southern district manager, with headquarters at Atlanta, Ga. J. H. Pearson, Jr., manager of the branch at Charlotte, N. C., will take charge of the Richmond house. E. E. Martin is now manager of the Syracuse Graybar house, succeeding E. D. Towler, who has been appointed assistant sales manager New York City.

Trade Catalogs

Boilers—The D. Connelly Boiler Co., Cleveland, Ohio, has issued in complete and handsome form an illustrated booklet on Connelly water-tube boilers. Various types of settings are given, and installations depicted.

Coming Conventions

American Electric Railway Engineering Association. Annual Meeting at Cleveland, Ohio, Oct. 4-8. Papers in power field Oct. 7. J. W. Welsh, 292 Madison Ave., New York City.

American Engineering Council. Annual meeting at Washington, D. C., Jan. 13-15. L. W. Wallace, 24 Jackson Place, Washington, D. C.

American Welding Society. Annual Fall Meeting, at Buffalo, N. Y., Nov. 16-19. Gideon W. Swan, general chairman, Morgan Bldg., Buffalo, First International Welding Exposition will be held in conjunction with meeting.

Engineering Institute of Canada. Annual meeting Jan. 18. Richard John Durley, secretary, 176 Mansfield St., Montreal, Que.

Midwest Power Show, at Chicago, Feb. 15-19. G. E. Pfisterer, managing director, 53 West Jackson Blvd., Chicago.

National Association of Practical Refrigerating Engineers. Annual Convention and Exhibition at Kansas City, Mo., Nov. 2-5. Edward H. Fox, secretary, 5707 W. Lake St., Chicago, Ill.

National Electric Light Association. A. Jackson Marshall, secretary, 29 West 39th St., New York City. Divisional meeting on the following date: Kansas Section at Manhattan, Kan., Oct. 14-16; H. Lee Jones, secretary, 401 National Reserve Bldg., Topeka, Kan.

National Exposition of Power and Mechanical Engineering, Fifth Annual Exposition at Grand Central Palace, New York City, Dec. 6-11.

Hoists, Trolleys, Cranes, etc.—The Wright Manufacturing Co., of Lisbon, Ohio, has just released a new catalog, No. 11, on chain hoists, trolleys, hand cranes and allied equipment. It contains cuts and general descriptive matter, and also line drawings giving all dimensions and clearances.

Turbo-Compressors and Blowers—The American Brown Boveri Electric Corp., 165 Broadway, New York City, has just put out a descriptive circular, No. 200, on a general and applied consideration of turbo-compressors and blowers manufactured by the company. Treatment is made of turbo-compressors for steel plants, blast-furnace turbo-blowers, scavenging turbo-blowers for Diesel engines, turbo-gas exhausters and gas boosters and pneumatic installations.

Plug Valves—The Merco Nordstrom Valve Co., subsidiary of the Merrill Co., engineers, has issued Catalog No. 5 on its plug valve product. This valve is of the plug cock type with lubrication and lifting features designed to make it easy and sure of operation by preventing leaking and stocking. Lubricant under pressure is used to release the plug against the compression of the gasket, and by the same operation a very small space is allowed into which a film of lubricant is automatically forced as the plug is turned.

Sil-O-Cel Insulating Brick — Celite Products Co., in a new bulletin, No. 103, describes the four types of Sil-O-Cel brick: C-22 brick, for service where the insulation will be subjected to temperatures between 1,600 and 2,000 deg. F.; super brick, for use under severe conditions, where the insulation may be subjected to temperatures as high as 2,500 deg. F.; rotary kiln brick, a special calcined form of Sil-O-Cel designed especially for the insulation of rotary cement and lime kilns, and standard brick, for service where the insulation will be subjected to temperatures no higher than 1,600 deg. F.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run except Pittsburgh gas slack:

Bituminous Net Tons	Market Quoting	Sept. 27 1926
Pool 1	New York	$2.50@$2.75
Smokeless	Boston	3.00
Clearfield	Boston	2.15@ 2.75
Somerset	Boston	2.00@ 2.15
Kanawha	Columbus	1.65@ 2.00
Hocking	Columbus	1.40@ 1.75
Pittsburgh	Pittsburgh	1.90@ 2.10
Pittsburgh gas slack	Pittsburgh	1.35@ 1.45
Franklin, Ill.	Chicago	2.35@ 2.50
Central, Ill.	Chicago	2.15@ 2.25
Ind. 4th Vein	Chicago	2.15@ 2.35
West Ky.	Louisville	1.10@ 1.50
S. E. Ky.	Louisville	1.50@ 1.85
Big Seam	Birmingham	1.75@ 2.00
Anthracite Gross Tons		
Buckwheat No. 1.	New York	2.15@ 3.50
Buckwheat No. 1.	Philadelphia	2.00@ 2.75
Birdseye	New York	1.40@ 2.00

FUEL OIL

New York—Sept. 29, light oil, tank-car lots; 28@34 deg. Baumé, 6c. per gal.; 36@40 deg., 6¾c. per gal. f.o.b. Bayonne, N. J.

St. Louis — Sept. 22, tank-car lots, f.o.b. St. Louis; 24@26 deg., $2.20 per bbl.; 26@28 deg., $2.25 per bbl.; 28@30 deg., $2.30 per bbl.; 30@32 deg., $2.35 per bbl.; 32@36 deg., gas oil, 6.13c. per gal.; 38@40 deg., 7.63c. per gal.

Pittsburgh—Sept. 21, f.o.b. local refinery; 30@34 deg., fuel oil, 5¾c. per gal.; 36@40 deg., fuel oil, 6¼c. per gal.

Dallas—Sept. 22, f.o.b local refinery 26@30 deg., $1.70 per bbl.

Philadelphia—Sept. 23, 27@30 deg., $2.52@$2.58 per bbl.; 13@19 deg., $1.59 @$1.65 per bbl.

Cincinnati — Sept. 28, tank-car lots f.o.b. local refinery, 24@26 deg., Baumé, 6½c. per gal.; 26@30 deg., 6⅝c. per gal.; 30@32 deg., 7c. per gal.

Chicago—Sept. 25, tank-car lots f.o.b. Oklahoma, freight to Chicago, 92c. per bbl.; 24@26 deg., $1.45@$1.50 per bbl.; 26@30 deg., $1.60@$1.65; 30@32 deg., $1.80.

Boston—Sept. 27, tank-car lots f.o.b. 12@14 deg. Baumé, 4¾c. per gal.; 28@32 deg., 6c. per gal.

New Plant Construction

Ark., Hot Springs—H. P. Hess, Archt., 1237 North Taylor St., St. Louis, will receive bids until October 6, for 5 story, 40 x 272 ft. hospital addition, with 3 electric elevators, for Sister of Mercy Hospital. Estimated cost $750,000.

Calif., Los Angeles—Owners c/o Walker & Eisen, Archts., Western Pacific Bldg., awarded contract for the construction of 12 story apartment building on Wilshire Blvd. to C. Thoren, 5615 West 41st St. Estimated cost $1,000,000.

Calif., Los Banos—Union Ice Co., 354 Pine St. San Francisco, plans the construction of an ice plant, here.

Calif., Oakland—Interests represented by C. Schlesinger, Mills Bldg., San Francisco, plans the construction of an office and stores building at 14th, 13th, Franklin and Webster Sts. Estimated cost $1,500,000.

Calif., Santa Barbara—D. Blankenhorn, et al. Pacific Mutual Bldg., Los Angeles, awarded contract for the construction of hotel to P. J. Walker Co., Sharon Bldg., San Francisco. Estimated cost $1,250,000.

Calif., Stockton—City is having plans prepared for 10 in. pump, 75 hp. motor and 50 hp. compensator to increase pumping capacity of North Sewage Disposal plant. W. B. Hogan, is city engineer.

Ga., Cordele—Crispe County plans an election in November, for $1,250,000 bonds for hydro-electric power dam.

Ga., Glennville—Glennville Manufacturing Co., is in the market for 20 ton oil engine, to be used in ice manufacturing plant.

Idaho, Boise — U. S. Veterans Bureau, Arlington Bldg., Washington, D. C., will receive bids until October 26, for furnishing and installing complete refrigerating plant, at U. S. Veterans Hospital, 52, here.

Ill., Chicago—T. Bishop & Son, Archts., 35 South Dearborn St. will receive bids about October 25, for 16 story hotel, with 3 elevators, vacuum heating system, etc., at 1032 North Dearborn St., for Statler Hotel Corp. Estimated cost $1,500,000.

Ill., Chicago—Syndicate, c/o A. Proskauer, Archt., 159 North State St. is having plans prepared for the construction of 12 story apartment at Sheridan Rd. and Granville Ave. Estimated cost $3,000,000.

Ill., Cicero—National Theatres Corp., 310 South Michigan Ave. is having plans prepared for the construction of theatre and hotel, at 22nd St. and 15th Ave., here. Estimated cost $1,800,000. J. Eberson, 212 East Superior St., Chicago, is architect.

Ill., Danville—Interstate Water Co., H. M. Ely, Supt. is receiving bids for the construction of 2 story, boiler plant. Estimated cost $50,000. Mead & Seastone, Journal Bldg., Madison are engineers.

Ill., Granite City—St. Elizabeths Hospital c/o Sister Superior, has postponed until spring taking bids for 4 story, 49 x 225 ft. and 43 x 80 ft. addition to hospital, on Madison St. Estimated cost $500,000.

Ind., Dana—Dana Water Co., will receive bids about October 15 for the construction of waterworks system, including pumping equipment, etc. Heer Engineering Co., 314 Star Bldg., Terre Haute, is engineer.

Ind., Morristown—Morristown Water Co., J. A. Zike, Pres. will receive bids until October 15 for constructing waterworks including pumping equipment, etc. Herr Engineering Co., 314 Star Bldg., Terre Haute, is engineer.

Ia., Spencer—City awarded contract for alterations and additions to light and water works, to Spencer Constr. Co., $33,548.

Kan., Kansas City—Newland Ice & Cold Storage Co., 17th and State St. is having plans prepared for the construction of an addition to ice plant, at 17th and State St. Estimated cost $75,000. Private plans.

Ky., Hazel—City is having preliminary plans prepared for the construction of waterworks system, including deep well pumps, etc. Estimated cost $18,000. C. Crawford, Murray is engineer.

La., Shreveport—Syndicate c/o Benson Realty Co., 502 Atkins St., is having preliminary plans prepared for the construction of 12 story, 133 x 150 ft. office building, at Travis and Louisiana Sts. Estimated cost $1,000,000. Long & Witchell Co., American Bank Bldg., Dallas, Tex. is engineer.

Mass., Boston — Adams House Hotel, Adams House, F. G. Hall, Mgr. is having preliminary plans prepared for the construction of hotel. Estimated cost $1,500,000. A. H. Bowditch, 44 Bromfield St. is architect.

Mass., Boston — Homeopathic Hospital Building Comn., 551 Tremont St., G. B. Glidden, Chn. is having preliminary plans prepared for the construction of hospital at Harrison Ave. and East Newton St. Estimated cost $1,500,000. Kendall, Taylor & Co., 142 Berkley St. are architects.

Mich., Detroit—L. Kamper, archt. Kamper Bldg. awarded contract for the construction of 34 story office building including steam heating system, on Woodward Ave. to O. Misch Co., 159 East Columbia St., for Eaton Estate, 204 Woodward Ave. Estimated cost $1,500,000. Electric elevators will be installed.

Mich., Utica—City is having plans prepared for the construction of filteration plant and pumping station, includuing 2 low head 300 g.p.m. vertical centrifugal pumps and 2 high head, 300 g.p.m. horizontal pumps, switches, etc. Pate, Beacon & Hamman, 602 Transportation Bldg., Detroit are engineers.

Minn., Rochester — Kahler Corporation, and Mayo Clinic, awarded contract for the construction of 2 and 3 story, power plant to G. Schwartz & Co., Rochester. Estimated cost $350,000.

N. J., Newark—Branford Holding Co., 810 Broad St., F. Briscoe, Pres., will build 3 story, 138 x 265 ft. store and office building, with vapor heating system, on Branford Pl. between Halsey and Washington Sts. Estimated cost $500,000. Work will be done by separate contracts under owners supervision.

N. J., Newark—Mount Prospect Avenue Co., Kinney Bldg., H. Van Dyne, Pres., awarded contract for the construction of 10 story, apartment with 3 electric elevators on Mount Prospect Ave. to Deakman Wells Co., 921 Bergen Ave., Jersey City. Estimated cost $800,000.

N. Y., New York—H. B. and S. O. Crystal c/o G. and E. Blum, Engrs. and Archts., 415 Lexington Ave., is having plans prepared 15 story, apartment, on East 57th St. Estimated cost $1,000,000.

N. Y., New York—Shelton Holding Corporation, c/o J. I. Cobb, Archt., 51 East 42nd St. awarded contract for the construction of 16 story apartment at 150 East 50th St. to J. A. Moeller, 51 East 42nd St. Estimated cost $600,000.

N. Y., New York—Sigley Realty Corp., 152 West 42nd St., is having plans prepared for the construction of office building, at 6th Ave. and 6th St. Estimated cost $600,000. F. P. Platt & Bros., 221 West 57th St., are architects. E. E. Seelye, 101 Park Ave., is engineer.

O., Cleveland—Kalman Kreinberg and W. A. Krasny, will receive bids about October 6, for the construction of 2 story and basement, packing house, including power plant, elevators, etc. Estimated cost $75,000. M. Weis, 617 Union Bldg., is architect.

O., Cincinnati—Chamber of Commerce, East 4th St. awarded contract for the construction of 14 story, office building at 4th and Race Sts. to Hodges Constr. Co., 241 Walnut St., $1,000,000.

Okla., Elgin—City, H. J. Dorman, Mayor, plans waterworks improvements, including pumping equipment, etc. Estimated cost $20,000.

Okla., Lawton — Southwestern Light & Power Co., 40 Exchange Pl., New York City, is having plans prepared for the construction of 20,000 kw. substation on Core St., increasing switchboard from 2,000 to 20,000 kw. capacity, 5 mi. transmission line, etc. here; also constructing 10,000 kw. substation at Elk City. Estimated cost $400,000. Private plans.

Okla., Ponca City—City is having preliminary plans prepared for the construction of improvements to light plant, including engine, dynamos, etc. Estimated cost $15,000.

Okla., Talihina—City voted $60,000 bonds for constructing waterworks improvements, including pumping equipment, etc. Estimated cost $60,000. P. H. Foster is Mayor.

Pa., Pittsburgh—Schmidt, Garden & Erickson, Archts. 104 South Michigan Ave., Chicago, Ill. and H. Hornbostel, Consult. Archt., Century Bldg., will receive bids until October 20, for group of hospital buildings, including 72 x 85 ft. power house, all with vacuum heating system, for Montefiore Hospital, 33 Center St., here. Estimated cost $1,500,000.

R. I., Providence—J. Conn, 104 Broad St. is having preliminary plans prepared for the construction of theatre, hotel and office building at Pine, Broad, Chestnut and Claverick Sts. Estimated cost $1,000,000. T. J. H. Pierce, City Hall is architect.

Tex., Bay City—Texas Central Power Co., Frost Bldg., San Antonio is receiving bids for the construction of 50 x 89 ft. 50 ton capacity ice plant, here. Estimated cost $75,000. J. Marriott, Frost Bldg., San Antonio is architect.

Tex., Dallas—Z. E. Marvin, Marvin Drug Co., has had plans prepared for the construction of 20 story, medical science building with 7 passenger elevators, on Live Oak St. Estimated cost $2,000,000. J. N. McCammon, Inc., Southland Life Bldg. is architect.

Tex., Terrell—City, J. P. Barnett, City Secy. is in the market for 225 to 360 hp. oil burning engine, direct connected to two 300 v. 3 phase, 60 cycle, alternater, with equipment, etc., 1 combination generator and exciter switchboard panel for municipal light plant.

Wis., Blanchardville—Wisconsin Power & Light Co., Gay Bldg., awarded contract for the construction of 30 x 74 ft. wheel house and plant, here. Estimated cost $40,000. E. J. Kallevay, c/o owner, is engineer.

Wis., Fond du Luc—Wisconsin Power & Light Co., 16 North Carroll St., Madison, is having plans prepared for the construction of 50 x 100 ft. addition to plant, here. Estimated cost $40,000. Balch & Lippert, Gay Bldg., Madison are architects.

Wis., Hartford—City, W. Radtke, City Clk., will soon award contract for the construction of sewage pumping station, including 2 sewage pumps, complete with motors and starters, etc. J. Donohue Engineering Co., 608 North 8th St., Sheboygan, is engineer.

Wis., Middleton—Golden Key Milk Products Co., 119 East Washington St., Madison, is in the market for 150 hp. tubular boiler and 3 mechanical stokers. Cahill & Douglas, 217 West Water St., Milwaukee are engineers.

Wis., Stevens Point—A. L. Shafton & Co., South 2nd St., is receiving bids for refrigeration machinery for wholesale fruit warehouse.

Wis., Wales—State Bd. Control, A. W. Bagley, Secy., Madison, plans the construction of 40 x 60 ft. power house, at State Sanitarium, here. Estimated cost $50,000.

B. C., Duncan—Cowichan Creamery Association J. Gible Mgr. plans the construction of a dairy, including an ice plant, here. Estimated cost $45,000.

New Zealand, Christchurch—Secretary Christchurch Drainage Bd., will receive bids until October 19, for 3 sets electric centrifugal pumping plants.

New Zealand, Wellington — Secretary Tenders Com., Public Works Department, will receive bids until November 30, for two triphase, 1,500 kva. transformers; and until January 4th for seven 1,000 kva. single phase transformers.